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SILICON AND ITS ALLOYS.

It is interesting to note how new processes give rise to new products which themselves may revolutionize older processes. For example, until recently metallic silicon was a chemical curiosity because of the difficulty of preparing it. Now that the electric furnace is available, metallic silicon can be obtained commercially, or silicon alloys can be made as easily. It is therefore probable that this metal, but recently added to our available materials, will become an important article of commerce. It is light, does not easily corrode; hence may be useful for such purposes as its chemical properties make it suitable. Its high heat of formation makes it a valuable reducing agent, and makes possible its use in the compound known as "calorite" for obtaining high temperatures easily. This use of silicon is similar to Goldschmidt's thermic process, which is becoming widely used for repairing castings and other similar work.

Another use of silicon or silicon alloys is in the production of special qualities of steel. The presence of silicon increases the permeability of steel, a valuable feature in the manufacture of steel for electrical apparatus. When the effects of silicon are better understood, it may enable us to make important changes in our methods of constructing electrical machinery.

There are other valuable properties of silicon compounds which will probably be made use of: certain of its compounds are excessively hard and will be a valuable aid to the lapidary. No doubt other arts will soon see where they can make use of these materials to good advantage, as soon as they realize that they are available and know the properties that they possess.

WEATHER REPORTS BY WIRELESS.

It is announced in the daily press that the United States Navy Department has arranged to receive weather reports by wireless telegraphy from all merchant ships fitted with the necessary apparatus. These vessels will make daily reports on the weather whenever they are in touch with the government receiving stations which are now being established along the coast from Portland, Me., to New Orleans, La. The stations will form a continuous chain along the Atlantic coast and the gulf, so that it will be possible for every vessel coming within a certain distance of the coast to get into communication with some station. At the same time, in addition to receiving reports from the vessels, they will, if they desire, be given the bureau's weather forecast by the land stations.

The transmitting of weather reports to and from vessels by means of wireless telegraphy was suggested some time ago as being one of the very useful purposes to which this system of telegraphy could be put. Notwithstanding all the criticism—humorous and otherwise—to which the weather reports are subjected, they form an exceedingly valuable part of the daily news; and in spite of all the ridicule, it is true that, should the weather bureau suspend the service, there would be a loud complaint from the entire country. A forecast of the weather should be even more valuable to ships at sea; but, until the development of an operative system of wireless telegraphy, there has been no means of communicating with them and warning them of approaching storms. Mishaps at sea are fortunately not frequent to-day, due to the strength of the ocean-going vessels and the skill of their officers; but a forewarning of a coming storm might enable many a vessel to avoid it or to suffer but little inconvenience from it. Heretofore the captain has been forced to depend upon his instruments and an acquired knowledge of weather signs. With the new service he will be warned of a storm long before it has approached his vessel or there is any local sign.

SOME OF THE UNSOLVED PROBLEMS IN ELECTRICAL ENGINEERING.

The aim of every engineering project is to accomplish a result never before attained, or to reach an old result by a newer, better or cheaper process. In either case, the ultimate success depends upon the return in dollars and cents. But however strictly this requirement applies in practice, it does not prevent us from looking forward and seeing what is desirable, and trying to imagine how our present methods could be changed for the better.

In an address recently delivered before the Institution of Civil Engineers, of Great Britain, Colonel R. E. Crompton indicated a goodly number of problems which are awaiting solution. Certain of these are of great importance, such, for example, as the direct production of electricity from fuel, or the invention of a more efficient electric lamp. These problems, as well as certain others, still baffle us, though we have spent much time and thought upon them. Occasionally we have thought there was hope, but in each instance we have been disappointed. We must never forget that an engineering solution must be obtained, as well as a physical one. A method of producing electricity directly from fuel would be of little value if it could not be applied commercially.

There are other problems confronting us which have received less attention. For example, the lecturer dwelt at length upon the "core and coil problem," as he put it—that is to say, the problem of improving electrical machinery. We want a method of producing castings which will be absolutely homogeneous and always of the same quality. To-day we build up our transformer or generator cores of laminated sheets—a method which is expensive and undesirable mechanically. If we could only make castings having high permeability and high resistance, we might be able to abandon the laminated construction. Some little work has been done in this direction, but no practical results have yet been obtained. In the coils themselves, which consist almost always of copper strips or wires wound with some non-conducting material, there is a great chance for improvement. The non-conducting materials used to-day are, as a rule, destroyed by heat. What we want is a fireproof coil.

The storage battery problem was dwelt upon also. We are still forced to depend upon the lead cell, in spite of the undesirable mechanical properties of this material. A cheaper and better storage battery is needed, not only as an auxiliary for station work, but for the electric automobile. Until a light and indestructible, or light and cheap, battery is available, the field of the electric automobile will be restricted. The last two or three years have given us the single-phase motor, which promises to extend greatly the range of the electric railway. There are, however, some other railway problems which might be solved by electrical means. It is suggested that the successful development of an electrical gear for changing speed and torque would be acceptable, not only for railway work, but for rolling mill and other purposes.

Although the electric furnace has made what seems to us to be great strides, it is probable that what we have done is almost insignificant to what will eventually be accomplished by means of it. We have improved old processes by means of the electric furnace, and added to our useful materials; and there is no doubt whatever that we will not only extend its application in furnace work generally, but that we will produce many more new and useful substances which are at the present time not obtainable.

Among a number of other interesting problems, Colonel Crompton referred to the transmission of power by means of Hertzian waves. It is a question whether we are ready for general transmission of power without having to resort to wires, but there is one particular phase of this application—that is to say, wireless telegraphy—where improved methods of transmitting power in small quantities are all-important.

Evidently, from what has been said above, there will be no lack of new fields to conquer for a long time to come. The young inventor will always find some line of work to which he can devote his enthusiasm and energy, with the hope of accomplishing important results. In fact, in not one of the many applications of electricity have we reached a point where we can sit back and say that we have perfected the method and there is no possibility of improving it.

ORNAMENTAL TROLLEY POLES.

The term "trolley pole" is used in two ways—one to designate the light iron pole which supports the collecting device upon the top of an electric car; the other—a less correct use—is where the same term designates the supporting pole for the overhead conducting system. The general public has, however, grown to identify the word "trolley" with an electric traction system. We have "trolley wheel," "trolley wire" and "trolley car," the last expression being used to designate an electric car in general, without reference to its method of obtaining power.

Ever since the electric car was adopted for city service, there has been a continual fight between the city through which the road is to run and the company building it. The latter naturally wishes to adopt the least expensive but satisfactory system, which is undoubtedly the overhead trolley. The former, being less concerned with the expense of the road, but having in mind the beauty of its streets, objects to the overhead construction and asks for an underground line. This being impracticable commercially, the city, except in a few cases, is forced to give in and allow the overhead wires, if it is to have the benefits of a system of rapid transit. But, having given way so far as the system is concerned, there is no reason why the city should not demand that the system installed should be made as little disfiguring as possible. If poles are to be put in, why should they not be ornamental rather than disfiguring? Any unnecessary obstruction in the streets should not be allowed, of course, and such as is necessary should detract as little as possible from the appearance of the streets. This plan is being carried out, to some extent, with regard to street lamps, for effort is made to obtain simple yet ornamental poles. Why should not the same rule be applied to the so-called trolley pole? The usually adopted type is anything but attractive,

though it could be made presentable at slight expense. Then, too, attention should be paid to the method of setting the poles. It used to be customary to give the pole a very decided lean away from the track, the idea being to allow for the spring of the pole due to the pull of the span wire; but this practice was often carried to excess, so that the poles leaned too far out, making anything but an attractive appearance. An ornamental iron pole, well set, would be far less disfiguring than the ugly device now in use, and which so frequently leans at such an angle as to be at odds with everything else on the street. There would be less objection from property holders to the erection of the poles if they knew they would not be a continual offence to the eye.

TELEPHONE SERVICE DURING THUNDER-STORMS.

During a recent investigation into the cause of a fire at a London exchange, one of the telephone experts said, in answer to a question, that it was better for the telephone subscriber not to use his telephone during a thunder-storm, and that it would be advisable for the exchange to discontinue its service until the storm was over. This is a rather surprising statement for a telephone man to make at this day, particularly as he can not show any records in support of his statement. We believe that if statistics were available, they would show that there is no more danger from lightning in using a telephone or operating an exchange than one is unavoidably exposed to anyhow, and the proposal to shut down the exchange until the storm is over would not be listened to for a moment in any important city on this side of the water. It is bad enough to have an interruption once in five years, say, due to some unexpected cause, but to shut off telephonic communication every time it thunders is not to be thought of.

DOUBLING THE CAPACITY OF A STREET.

An interesting and striking suggestion was made recently by a well-known engineer. It was that the traffic-carrying capacity of New York's great highway, Broadway, would be doubled if horse-drawn teams were excluded from it, and all traffic carried by mechanically propelled vehicles. Startling as this suggestion is, a little consideration would seem to show that it is really a conservative statement. It was based largely upon the saving in space obtained by cutting off the horses, but the saving in time, and therefore the increase in capacity due to the method of propulsion, should be as important. This saving would be effected by an allowable increase in speed, and by the greater facility with which such vehicles are controlled. At the same time, greater loads can be carried for a given area occupied by a vehicle. The engineer referred to above said that he believed it would be but a short time before the horse became a rare object in New York.

The suggestion just quoted is well worthy of being considered seriously. It would seem to be the simplest solution of the important problem of increasing the traffic-carrying capacity of the streets of the metropolis. At the same time, other advantages would be gained; for instance, a decrease in the wear and tear of the streets, an improved hygienic condition, less noise.

A NEW ERA OF RAILWAY OPERATIONS.

The problems confronting the railway companies of the world have an unusual interest to the general public, as is shown by the fact that more attention is paid by it to the conditions existing and the proposed solutions than to the changes going on in most other fields of human activity. The reason, of course, is the personal interest which everybody feels in some particular line of transportation. Nearly every one to-day depends more or less upon some railroad, either for transporting his goods or himself.

Some years ago the greatest interest was centered in the city railway lines during the transformation to electrical operation. Now that this has been practically completed, and as the electric system has not been satisfied with the city district, but has extended into the country, and has entered into competition with the steam roads, the question naturally is, what are the steam roads going to do? Will they electrify? Until recently there were two sharply divided classes. The first—and by far the larger one—held that the electric motor could not perform the work of the steam locomotive. The other, and smaller, class took decidedly the opposite stand, and boldly asserted that not only could the electric motor do the work of the steam railroad, but that, within a few years, it would be doing it, and the steam locomotive would disappear. Naturally neither one of these two extreme views was the correct one. It is to-day generally acknowledged that, so far as the actual moving of the trains is concerned, the electric motor can do the work better than the steam locomotive. But there are other phases of the problem which are just as important—in fact, usually the most important one is, will it pay to convert the steam roads to electric? The whole situation is excellently summed up in a few words spoken by Mr. George Westinghouse during the opening exercises of the American Railway Appliance Exhibition, held in Washington in connection with the International Railway Congress. He stated the case as follows:

A new era in railway operations has dawned with its many new problems. I refer to the growing use of electricity for the movement of trains. There have already been such demonstrations of the benefits to be derived from the substitution of the electric motor for the steam locomotive that it requires no great prophet to predict the extensive growth of electric traction upon the great railways of the world and the eventual replacement of the steam locomotive. Fortunately, the time element, which is such a controller of events, and the financial problems involved, will ensure gradual development and extension of the use of electricity.

With these changes have come vastly different engineering problems and new sources of danger, which should, and will, command and receive that attention which is essential to the surmounting of every difficulty as it arises.

This covers the situation exactly. It will be seen that Mr. Westinghouse has no lack of confidence in what the electric motor will do; yet he, at the same time, recognizes that time is necessary to bring about the evolution.

Electric Traction on the North Eastern Railway.

A Very Successful Electrical Passenger and Freight Service Instituted in Place of Steam.

THE electrification of the lines of the North Eastern Railway Company at Newcastle-on Tyne, and neighborhood, England, presents a very recent example of the application of electricity for the moving of both passenger and freight traffic. The work of electrification and the equipping of the apparatus was carried out by the British Thomson-Houston Company, Rugby, England, to whom we are indebted for data and illustrations. The trains are worked by continuous current obtained from a single conductor rail placed in the six-foot way, with the track rails forming the return. The conductor rail is of special high-conductivity steel, of Vignoles section, weighing eighty pounds to the yard. The rail is carried on reconstructed granite insulators supported upon cast-iron pillars. These are placed 19.25 inches outside the gauge line. The separate conductor rails are normally placed between the double tracks; at junctions, crossings, etc., the conductor rail is transferred to the outside of the track. At stations, and at level crossings, the conductor is protected by two creosoted boards, bolted against distance pieces on each side of the rails.

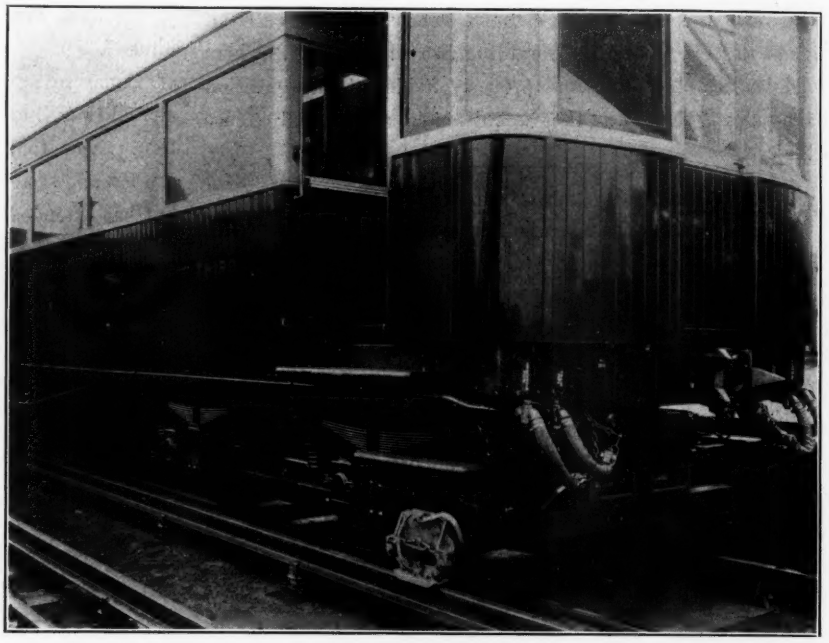
The North Eastern Railway Company buys its energy from the Newcastle Electric Supply Company. This company's Carville station, which supplies the energy for the railway, has been fully described in the ELECTRICAL REVIEW, December 24, 1904.

The motor coaches and trailer coaches are of the open corridor type. Each coach is carried on four-wheeled bogie trucks. The coaches are both lighted and heated electrically. The motor and trailer trucks are of pressed steel, with steel side frames, bolsters, cross-bars and end-bars. The wheel base is seven feet. The swinging bolster is of ash, is stiffened on the sides with steel angles, and is supported upon two nests of springs, each nest consisting of one inside and two outside springs. The axle-boxes are of cast steel, with seatings on the top for laminated bearing springs; the horn blocks of the axle-boxes are of cast steel, and they are tied together at the bottom by a steel strap. The journals are eight inches by 4.5 inches, and the end journals are of the best gun-metal. At the driving and gear-wheel seats the axles are 5.75 inches in diameter, and at the centre and at the motor suspension bearings the axles are 5.25 inches in diameter.

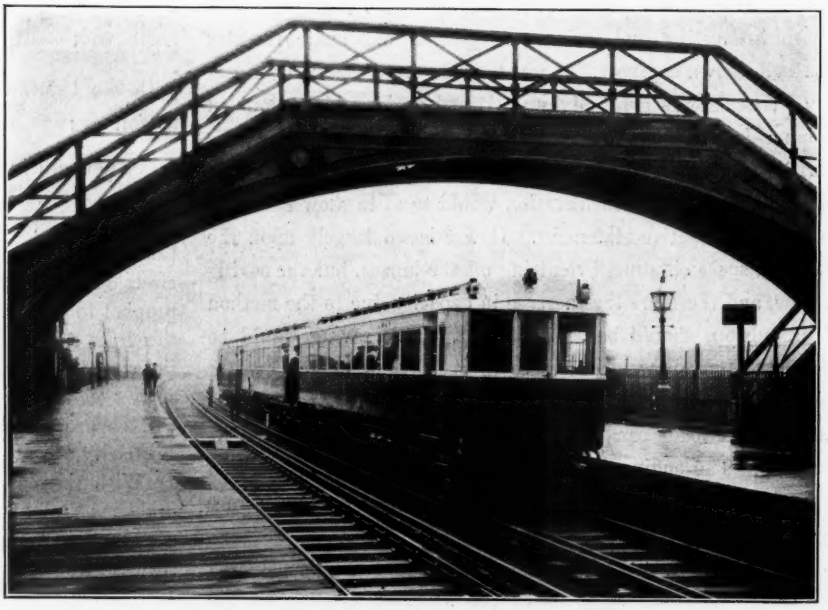
The wheels have wrought-iron or mild steel centres, and Siemens-Martin steel tires, thirty-six inches in diameter on the tread. The tires are 5.5 inches wide, formed with a lip on the front side, and they are held in place by a retaining-ring on the opposite side after being forced on.

The collector shoe is carried by an oak beam from each side of the motor truck. Brackets are cast on the ends of the journal boxes, and these carry the beam at the proper height above the track. Each shoe is protected by a magnetic blow-out ribbon fuse. There are four contact shoes, one at each side of each bogie truck.

The motors are suspended from angle



FRONT VIEW OF MOTOR CAR, SHOWING COLLECTOR SHOE RUNNING ON THIRD RAIL, NORTH EASTERN RAILWAY.



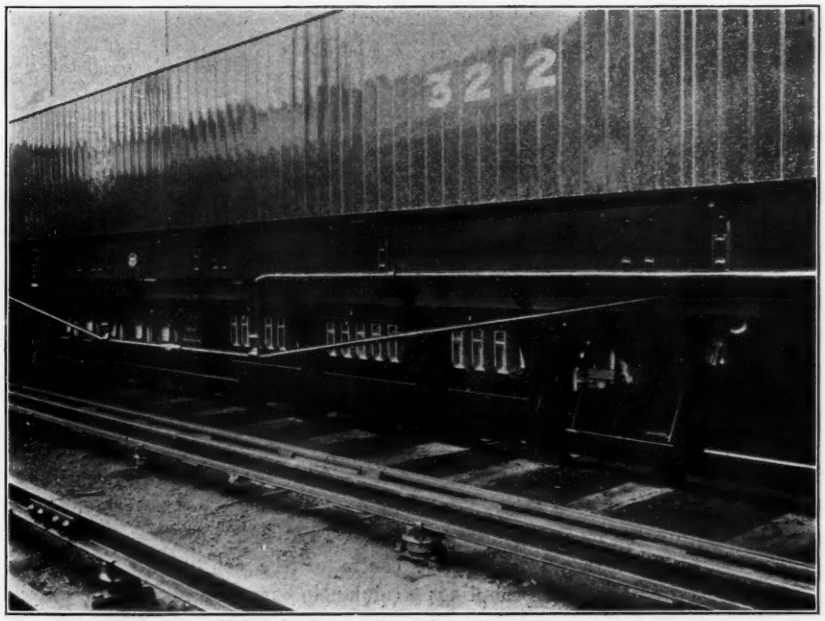
MULTIPLE UNIT TRAIN, NORTH EASTERN RAILWAY.

brackets bolted to the transom, on which rests the supporting nose cast on the motor frame. A stiff strap, bolted to the angle bracket, holds the nose rigid.

Two G. E. 66 motors, each rated at 150 horse-power, are placed on each motor coach. Both motors are carried on one bogie truck.

Bonding the Tracks, North Eastern Railway.

The ordinary unit train consists of two motor coaches with one trailer coach between. The Sprague-Thomson-Houston system of multiple-unit control is used. Beneath each motor coach are fixed the contactors for making the necessary connections with the motors and for cutting in and out the resistances, step by step. The contactors are operated by current derived from a nine-wire multiple cable running from end to end of each motor coach, and fitted with a proper socket and plug coupler at each end. The trailer coaches are also fitted from end to end with these multiple cables and the system is thus made continuous throughout the train. The rate of acceleration of the train is maintained constant until the full multiple position of the controller is reached. The driver is only required to throw his lever to full multiple or full series position and hold it there until he wishes to shut off the current. The entire train is synchronously controlled from the forward car.



View Showing the Contactors underneath the Cars, North Eastern Railway.

For the freight traffic powerful electric locomotives have been developed by the British Thomson-Houston Company. These are of the double bogie type with central cab and sloping ends and weigh in running order fifty tons. The motors are the G. E. 55 type with two-turn armatures and 3.28 gear ratio, one being mounted on each of the four axles. The control adopted is the Sprague-Thomson-Houston multiple unit system and is similar to that used on the passenger trains. The following gives the leading dimensions:

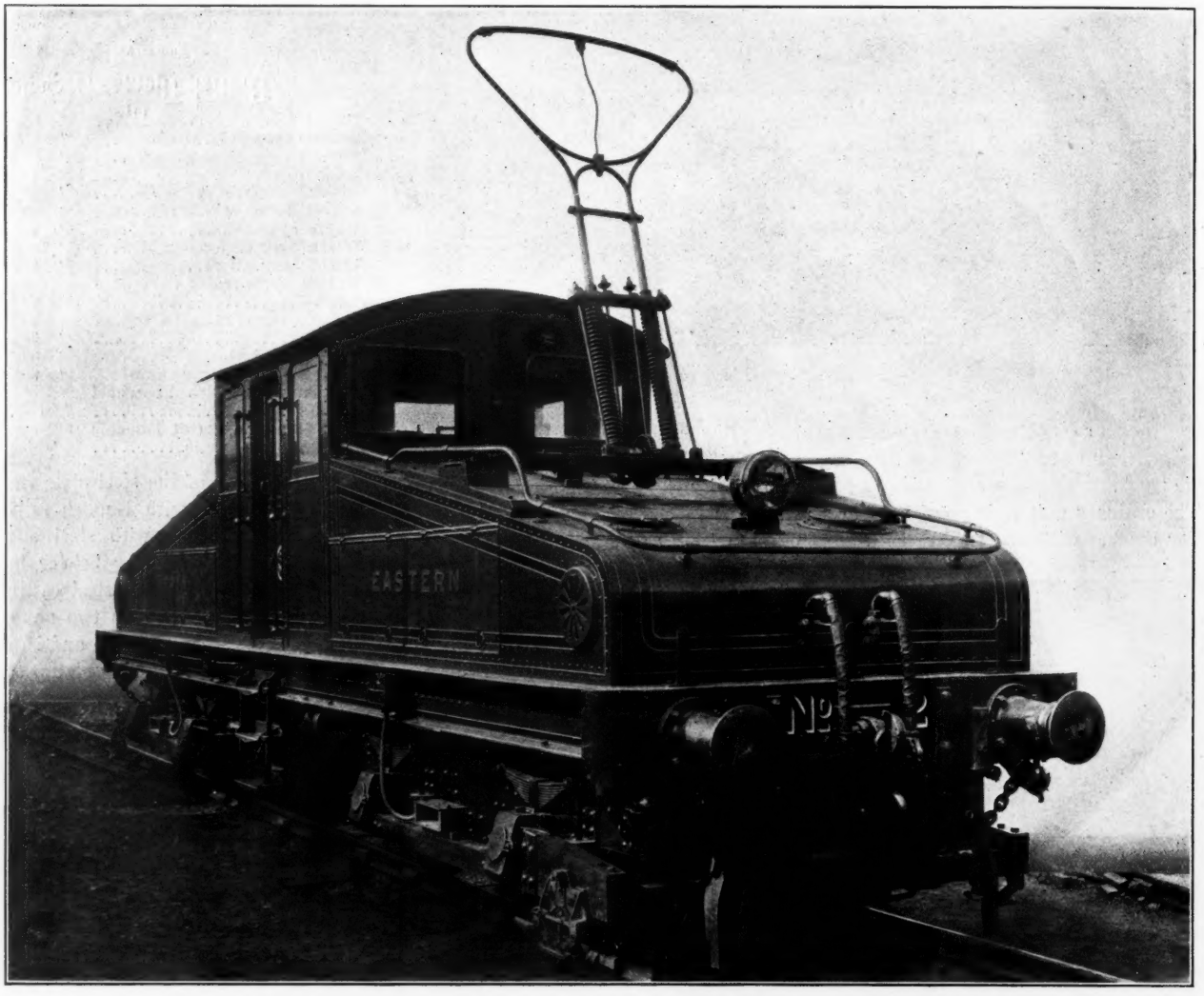
Gauge	4′ 8½″
Length over central cab	9′ 0¼″
Length over head stocks	35′ 0″
Length over buffers	37′ 11″
Pivotal centres of trucks	20′ 6″
Wheel base of each truck	6′ 6″
Width over cab	7′ 6¼″
Width over side soles	7′ 10⅝″
Width over all	8′ 8″
Height from rails to top of cab	11′ 9″
Height from rails to top of floor	4′ 3¾″
Diameter of wheels	3′ 0″
Diameter of axles at centre	0′ 6⅜″
Diameter of axles at wheel seats	7.28
Diameter of axles at journals	6″
Length of journals	10″

The trucks are of the steel-plate frame type in accordance with English railway practice, strengthened with steel angles and gussets with swinging bolster built up with steel sections and steel castings. The bolster is supported on two nests of coil springs of circular section and is provided with cast-steel wearing-plates, cast-steel centre and side bearing-plates. The side frames are supported on the axle-boxes by laminated springs of heavy design. The axle-boxes are of cast steel machined to work in the horn plates which are also of steel and machined, being riveted to the side frames which are cut out to receive them. The axle-boxes are provided with wings to take the shoe beams and are fitted with heavy brasses babbitted, ample provision is made for lubrication and exclusion of dust. The brake gear is of specially heavy design, as it plays an important part in the work that the locomotive has to handle which is chiefly on heavy grades, blocks are fitted to each side of each wheel, and all gear is heavy enough to stand operation by air pressure. The wheels are of the cast-steel disc type, balanced, and fitted with rolled steel tires 5.5 inches wide by 2.5 inches deep on tread, held in place by retaining-rings and also by eight set screws. The motors are carried on the transoms by means of cast-steel brackets in which

the nose on the motor frame rests, being held there by a forged strap. The shoe beams are of oak and bolted to the axle-boxes, the shoes being hung outside the wheel base. All holes are drilled, edges of plates planed and rivets hand-riveted.

The underframe is constructed of steel sections and ballasted with cast-iron blocks to bring up the weight. Each side sole is formed by a girder twelve inches by six inches by fifty-four inches and of I-section; there are two centre longitudinals, each eight inches by three and one-half inches by five-eighths inch of channels section, these four longitudinals being connected at their ends by head-stocks fifteen inches by four inches by one-half inch of channel section; to the front of these is bolted oak head-stocks fifteen and three-quarters inches by eight inches. The whole frame is firmly riveted together with steel angles and gussets, all holes being drilled and edges of plates machined. The underframe bolster is formed by two girders, each six inches by five inches by one-half inch of I-section, held together on the top by a plate three feet wide and three-quarters inch thick, on the lower side being a plate seventeen inches wide by three-quarters inch thick. Between the bolsters, evenly spaced, are five cross-girders, each eight by three and one-half inches by five-eighths inch of channel section, backed with a plate fifteen inches wide by one-half inch thick. On the top of the frame is a floor of fireproof wood one and seven-eighths inches thick, fixed transversely with a top or lining floor of seven-eighths inch thickness laid longitudinally. The draw gear, side couplings and buffers are of the standard English pattern.

The centre cab is constructed of one-eighth-inch steel plate and angles, and is separate to the sloping ends which are also constructed in a similar manner, all three portions being bolted to the underframe. The cab is provided with two side windows on each side, the one at the driving corners being arranged to lower. A sliding door is fitted on each side, of ash, glazed at the top, and panelled at the bottom, bearing on the outside the arms of the company in transfer. The doorways are two feet four inches wide, and six feet in the clear. At the ends of the cab are two windows arranged to slide transversely. Arrangements are made for driving the locomotive from each end of the cab, and it is therefore fitted complete in duplicate with master controller, air-brake, sand and whistle valves. In the centre of the cab is fitted a cast-iron column to carry the hand brake gear; on each side is a panel for the control and pump circuit accessories with a main panel at one end for main and control switches, etc. Air-gauges and ammeters are also fixed in each driving position. Under the sloping ends are fixed the contactors, reversers, and rheostats. The apparatus for each two-motor equipment



ELECTRIC LOCOMOTIVE FOR FREIGHT TRAFFIC, NORTH EASTERN RAILWAY.

being fitted in its own end of the cab, the four-motor equipment is thus split up into two equipments as far as possible as regards location. The contactors are supported from an angle-iron framing built on the floor of the cab, the reversers and resistances being bolted to the floor, but raised above it so that the cable runways may run underneath them. The air-brake is of the quick-acting pattern, air being supplied by a British Thomson-Houston electrically driven compressor, which is hung underneath the frame. This compressor will compress against a pressure of ninety pounds per square inch, with a cylinder displacement of twenty cubic feet per minute. The air reservoirs are fixed in the sloping ends of the cabs, as also are the sand hoppers, the sand being carried by flexible tubes to the fixed pipes on the trucks, the air-operating pipes being connected to the same at the base of the hoppers.

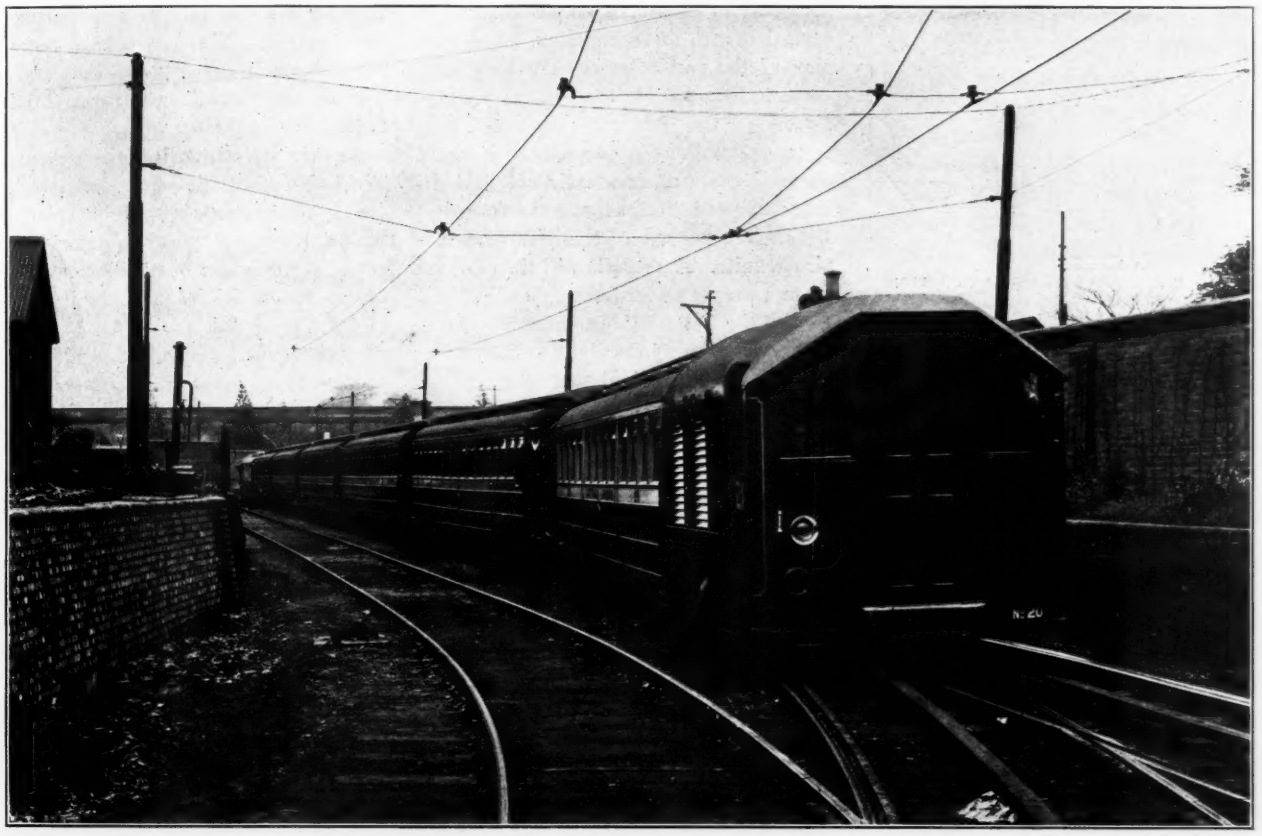
A shaded lamp is fixed in each driving corner with three lights in each of the sloping ends, and a headlight on each end. All lamps are of thirty-two candle-power, and arranged for working six in series on a 600-volt circuit. Two portable lights are also provided.

As the locomotives have to operate over sections fitted both with overhead line and third rail, a sliding bow trolley has been provided of special design, automatically reversing itself according to the direction of travel of the locomotive, and also capable of being reversed and lowered when not in use from the cab by a hand-wheel actuating a worm and wheel device.

All cables are asbestos covered, and are run either in wood troughing lined with uralite or in steel tubing. Besides being fitted with the nine-wire coupler at each end for the control circuit, bus or main-line and pump-line couplers are also provided, so that two locomotives can be coupled together if necessary and operated by one man for dealing with heavier loads.

Each locomotive when operating on a 600-volt circuit is capable of handling a 300-ton train on the level at a speed of fourteen miles per hour, and of starting with a train of 150 tons on a grade of 1 in 27 under all conditions of weather, running up this grade at a speed of nine to ten miles per hour.

It is interesting to note also the physical appearance of the multiple-unit train (illustration herewith), on the Central London Railway, which was opened in July, 1900. This apparatus was also designed and equipped by the British Thomson-Houston Company.



MULTIPLE-UNIT TRAIN, CENTRAL LONDON RAILWAY.

A Simple Condenser with a Variable Capacity for Experiments in Syntonization.

A simple condenser having a variable capacity is described by Herr J. J. C. Müller, who has used the device in experiments in syntonization of electrical oscillating circuits. The conducting plates of the condenser are thin sheets of zinc; the dielectric plates, of glass. The latter are assembled by cementing with shellac strips of glass twelve millimetres wide along two sides and one end of a plate. On these strips a second glass plate is cemented, and on the latter, a second series of glass strips, leaving, however, the plate uncovered at the other end. This process is continued until the desired number of glass cells is formed. The zinc sheets are clamped together in two sets by means of bolts, sleeves and nuts, and are then slipped into the glass pockets from opposite sides. By varying the distance to which one set of plates is inserted, the capacity can be varied continuously. With this device, syntonization between two circuits is easily shown, for there will be a certain position for which the current flowing in the secondary circuit will be a maximum. This point can be determined by means of an air thermometer, the bulb of which contains a fine resistance wire. By varying the inductance of either circuit, it is found necessary to vary the capacity of the condenser to secure the maximum current gain.—*Physikalische Zeitschrift (Leipsic), April 15.*

THE LIGHTING OF RAILWAY CARS.

BY E. L. ELLIOTT.

This article was inspired by a brief editorial in a recent issue of the New York *World*. The editorial was brief enough to be quoted in full: "The Subway Cars Should Be Better Lighted, Mr. Belmont." In view of the fact that the subway cars are provided with electric lamps in a

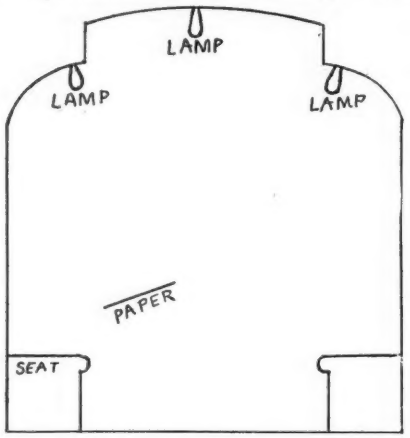


FIG. 1.—CROSS-SECTION OF CAR SHOWING POSITION OF LIGHTS.

more generous manner than is customary, the occasion for this public criticism of their lighting is worth investigating.

If the cars are really poorly illuminated, as the *World* declares, the correction of the fault is a problem requiring the services of an "illuminating engineer." The electrical engineer has done his best, and the result is unsatisfactory: a convincing argument in favor of the specialist in illumination. The writer has, for a number of years, been calling attention to the need of such specialists in the engineering field, and is gratified to observe that the suggestion is at last finding approval, as indicated by Mr. Marks's recent article in the ELECTRICAL REVIEW.

The old notion that the installation of a certain number of lamps of given "candle-power," in any position convenient to the wireman, is all that is necessary to "light" a room or car is on a par with the practice of our grandfathers in building a fireplace on one side of the room, from which to heat the room. "Fire makes heat; if you build a fire in your room, you will therefore heat your room." The argument appears unassailable—until you learn by experience how miserably ineffective and uncomfortable such heating is. "Lamps give light; put up enough of them, and you will have a brilliantly lighted room." The argument is just as plausible, and just as fallacious as the other. The discrepancy in both cases arises from the fact that only the physical effects are considered; while the results sought are purely physiological.

A room is well and properly heated when we feel comfortable in it, no matter what the thermometer may say; and a room is well illuminated when we can see the objects we wish to see with ease and comfort to the eyes, regardless of the "candle-power" and number of lamps in use.

The principles underlying the use of light for the production of illumination are sufficiently scientific and definite, and in the present highly developed state of the ways and means of producing light involve a sufficient number of technical problems to afford an ample field for a special branch of engineering. A discussion of the particular case in hand may serve to demonstrate the general proposition.

In the present case we have a small enclosed space of accurately specified dimensions, and electricity as the source of light. The purpose of the illumination is also definite. The results will then depend upon a proper understanding and application of the following elements:

The location of the light sources.

The number of light sources.

The light-power of the light sources.

The distribution of rays from the light sources.

placed along the ceiling as indicated are directly above the position in which a newspaper would be held for reading, and also in such position as not to be obscured by standing passengers. The lamps placed in the ceiling of the clerestory, or "well," serve to give additional light in the aisle, and also to illuminate the ceiling sufficiently to prevent any impression of gloominess, which a dark ceiling is sure to give.

The number of lamps in this case is subject to but one structural condition, namely, that it shall be a multiple of five or six in order to run in multiple series on the current supplied, without necessitating the use of lamps of special or unusual voltage. Ten lamps have therefore been placed in each side of the cars, and five in the "well," making a total of twenty-five lamps.

As originally installed, the lamps were all of sixteen candle-power, but later ten-candle-power lamps were substituted. As the total flux, or "mean spherical candle-power" of the sixteen-candle-power lamp of the type used is 13.2, the total quantity of light produced was 25 by 13.2 equals 430 mean spherical candles. With the ten-candle-power lamps it is reduced to 268 candles. The cubic contents of the car is 2,500 cubic feet in round numbers. With the sixteen-candle-power lamps the

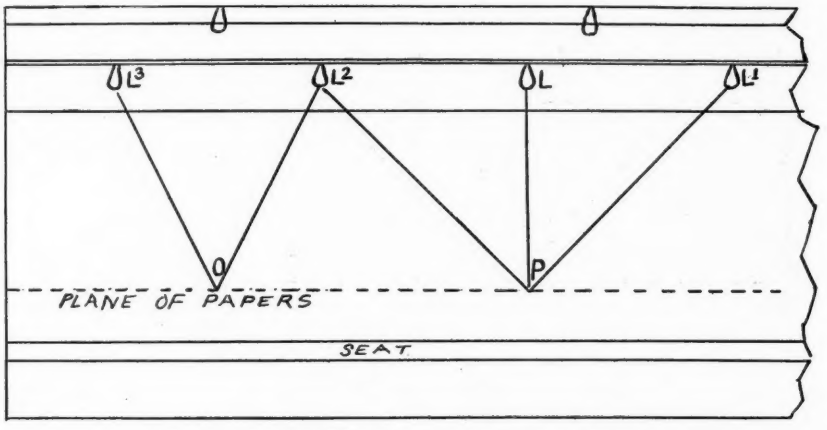


FIG. 2.—PLAN OF CAR SHOWING POSITION OF LIGHTS.

The distribution required to produce the most satisfactory illumination.

The quality of the illumination—diffusion and color.

The location of the lamps will be such as to produce the desired distribution of light subject to the structural conditions of the cars. These conditions are fortunately most advantageous, permitting the placing of the lamps in positions theoretically ideal. Fig. 1 shows a diagram of a car in cross-section, and Fig. 2 the same in longitudinal section. Lamps

average illumination was one candle to six cubic feet of space, and with the ten-candle-power lamps one candle to 9.4 cubic feet. For the general illumination of interiors one candle to twenty-five cubic feet is considered a very liberal allowance. Even with the ten-candle-power lamps, therefore, the total quantity of light produced is all that is necessary. The source of the trouble, whatever it may be, must therefore be sought in the distribution of the light and its quality.

The illumination demanded by the

public in this particular case requires unusual brilliancy in certain positions. The passenger with weak eyesight expects to be able to read his newspaper without fatigue or strain. Considering that newspaper print is often very fine, as well as poorly done, and even in some cases on colored paper, and also that the motion of the car gives additional work to the eye in keeping the focus on the desired point, it will readily be seen that more than ordinary intensity on the paper, as usually held for reading, is requisite for completely satisfactory results. An intensity of one foot-candle is generally conceded to be the minimum for reading average print without abnormal fatigue. It would not be out of the way, therefore, to increase the minimum in the present case to two foot-candles.

A glance at Fig. 1 will show that, with the paper held in the usual position, the lamps on the opposite side of the car have little effect, as the light strikes the paper at a very wide angle. At most, therefore, but three lamps can be considered, the one directly above, together with the two adjacent lamps; or if one is sitting between the lamps, then two only can be considered. If the car is crowded (a condition which sometimes occurs!) it may easily happen that only one lamp shines on the paper of the passengers, the light from the others being cut off by the papers of his neighbors. The distance

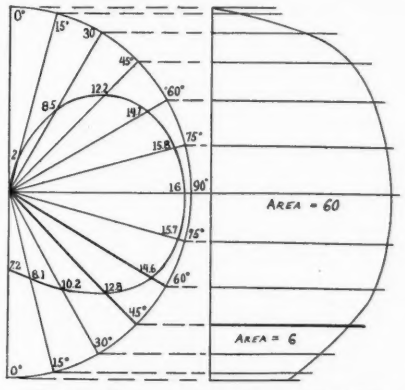


FIG. 3.—DISTRIBUTION CURVE OF LAMP.

from the lamp to the paper may be taken as 4 feet, and the plane of the paper as normal to the rays. The angle of incidence of the rays from the two adjacent lamps may be taken as 45 degrees. These conditions are shown in diagram in Fig. 2, and the curve of distribution of the type of lamp now in use is shown in Fig. 3. Since the vertical intensity is seven-candle-power, the illumination on the paper will be seven-sixteenths foot-candle from the lamp at L. The intensity at 45 degrees is 12.5 candle-power and the distance 5.6 feet. The illumination will therefore be $12.5 \div 5.6^2 \times \cos 45° = 1/3$ foot-candle from one lamp, or 2/3 foot-candle from the two L′ and L″. The total illumination on the paper from the three lamps may therefore be considered as 1 1/4 foot-candles, with the use of sixteen-candle-power lamps, or

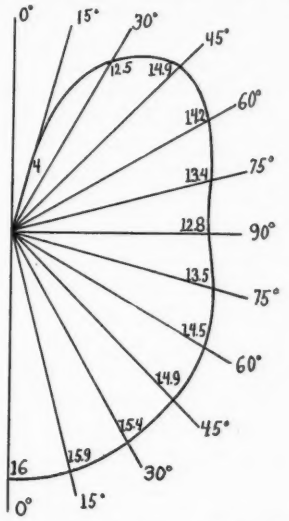


FIG. 4.—CURVE OF DISTRIBUTION OF LAMP GIVING MAXIMUM LIGHT VERTICALLY.

3/4 foot-candle with ten-candle-power lamps. The illumination midway between two lamps figures a little less than this amount. In addition to this there is some reflection from the ceiling, and some light from the lamps in the "well;" but on the other hand there is a very considerable fall in candle-power when the motors are doing heavy work, so that the figures given probably represent about the minimum illumination. It appears, therefore, that the complaint of insufficient illumination is not without cause.

Considering that the total quantity of light produced is more than double the amount ordinarily used for general interior lighting, the question naturally arises, "what becomes of all the light?" A little further figuring will doubtless answer this question. For reading purposes we have seen that only the light within the cone of 45 degrees can be considered, at least in determining the minimum. Drawing the curve for the total flux of light, Fig. 3, and calculating the relative areas representing the quantities given out above and below the angle of 45 degrees from the vertical, we find that 90 per cent of the light is given out above this angle, and therefore unavailable for reading, which we have assumed as the test. By referring to Fig. 1, it will be seen that the strongest rays fall on the advertising cards on the side near the lamp, and on the cards and ventilators of the side opposite. In short, the bulk of the light produced falls on the upper part of the car, where only the minimum amount is required. This distribution gives the general appearance of brilliant illumination; an effect which is found to be deceptive as regards the special illumination which we have taken as a test.

A further complaint might justly be made against the use of bare lamps. The location of the lamps is such that it is impossible for the eyes to avoid the direct encounter of more or less of the direct rays, to their inevitable discomfort. Thus, instead of the lamps on the opposite side of the car being of assistance they actually interfere with comfortable reading by throwing their rays directly into the eyes of the reader. Americans have not yet recognized the indisputable fact that the intrinsic brilliancy of an incandescent lamp filament is entirely too great to be encountered without serious discomfort to the eyes. In this respect European practice is far ahead of the American; a bare lamp in an electric car would be considered a barbarity. The use of bare lamps in the present case is the more indefensible from the fact that a super-

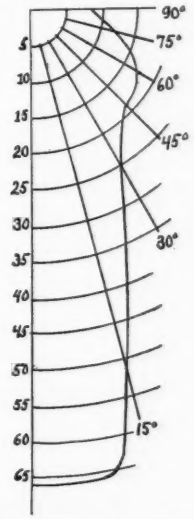


FIG. 5.—DISTRIBUTION CURVE OF SIXTEEN-CANDLE-POWER LAMP WITH HOLOPHANE REFLECTOR.

abundance of light is produced, so that the ten to twenty per cent reduction caused by frosting the lamps would not be seriously missed.

The figures obtained by our calculations, which must be considered rather as reasonably close approximations than absolutely accurate results, disclose the defects and point the way to their removal. A change in the general distribution of the light, so as to produce the strongest illumination in the lower rather than the

upper portion of the car, and the use of frosted in place of clear lamps in order to remove the glare of the filaments, would remove the only possible causes of complaint.

A considerable improvement in distribution could be secured by the use of a lamp so designed as to give its maximum light vertically. The distribution curve of such a lamp is given in Fig. 4. With the use of such lamps the illumination on the newspaper in the position assumed would be two foot-candles for sixteen-candle-power lamps, or 1 1/4 foot-candles for ten-candle-power lamps. As this illumination is nearly double that obtained from the lamp now in use, such a change would go a long way toward remedying the defect noted.

By the use of reflectors the distribution could be changed still further. Translucent reflectors are the only kind available for general illumination, as opaque reflectors darken the ceiling too much. Translucent reflectors are made either of opal glass, or clear glass with prismatic ribbings. On account of their higher efficiency, as well as more elegant appearance, prismatic reflectors alone may be considered. These are now made in such great variety of form, and so carefully calculated for the different uses to which they are adapted, that practically any desired distribution may be obtained by selecting the proper reflector. The curve of a sixteen-candle-power lamp of the type now used, in connection with a Holophane reflector (No. 2575), is shown in Fig. 5. Computing the values from this curve, we find that the illumination on the paper would be five foot-candles for sixteen-candle-power lamps, and three foot-candles with ten-candle-power lamps. The illumination would also be practically the same between two lamps as it is directly under one. By this simple expedient of using a reflector, therefore, a minimum illumination that is ample for the most exacting use of the eyes could readily be obtained, without taking into account the lamps in the "well," which would preferably be frosted and used without reflectors to serve their purpose of illuminating the upper part of the car. The prism glass reflectors would transmit sufficient light to illuminate the advertising cards.

That the use of any accessory to vary the distribution of the light was not contemplated before the cars were put into service is manifest from the fact that no provision was made for holding a reflector or globe in place. Possibly it was thought that the breakage of glassware would be a serious matter; but the general use of rather fragile blown glass globes in railway coaches is a sufficient answer to this objection. With the use of frosted lamps and prismatic reflectors the illumination of the cars would fulfil the most rigid specifications that the illuminating engineer could require, and would satisfy that most exacting patron, the general public, whose right to "kick" is cherished as its most inalienable privilege.

A New Oscillograph Wave Tracer.

Mr. Rudolf Goldschmidt has recently described a simple and neat wave tracer. He has taken advantage of the behavior of a small steel needle when placed between two magnetic poles, but in contact with one of them. In this position the needle stands vertically, assuming the poles to be arranged in a vertical position. Any lateral force will deflect the needle slightly, but it will return, when released, to its former position. The oscillograph consists, then, of two opposite poles, one above the other. On the face of the lower pole a steel needle about one-eighth of an inch in length stands on its point. On opposite sides of the needle are placed the coils through which the current to be traced is passed. The upper end of the needle is polished so as to reflect a small beam of light from a suitable source upon a screen. This arrangement would give merely a straight line. To get a curve, two forces at right angles must be used. The latter is obtained by passing a current from the same source through a second pair of coils, these coils containing a high inductance which not only retards the current through the circuit by approximately ninety degrees, but which smooths out the upper harmonics, leaving nearly a simple harmonic force. In the actual device a compound circuit is employed, so as to obtain exactly ninety degrees between the two forces acting upon the needle. The device, as thus arranged, throws upon the screen a curve which represents the wave form. This is a closed curve, and to get it in the usual form it is only necessary to reverse the lower or upper parts. The harmonic force which is used to spread out the line into a curve does not give a deflection directly proportional to the time, as it should. To overcome this objection, the screen is given a semi-circular form, whereby the time error is rectified. The apparatus may be fitted with two or more needles for studying the different currents flowing at the same time. The necessary damping is provided by the eddy currents set up by the motion of the head of the needle in the opposing pole-face. This damping can be regulated by varying the flux density of the magnetic field or the distance between the poles, or by putting a small copper plate on the face of the opposed pole.—*Electrician (London), April* 14.

Lightning Rods.

M. R. Chavannes discusses the general prejudice against lightning rods, and calls attention to the need of investigating more thoroughly the value of these devices so as to remove this feeling. A distinction is drawn between lightning arresters (parafoudres) and lightning rods (paratonnerres), the former being that type of apparatus intended to protect objects insulated from the earth, and the latter protective devices for objects not so insulated. The reliability of lightning arresters has been taken up by a Swiss commission, but its report has not yet been made public. M. Chavannes holds that lightning rods are valuable protective devices when properly installed, but the way in which this should be done is not well recognized. The original idea of a lightning rod was a device which would allow atmospheric charges to escape slowly to the ground, but, in fact, the action of the device is generally otherwise. Discharges are sudden and severe, and have apparently an oscillatory character. M. Chavannes has conducted experiments on a laboratory scale, with a view of studying the effect of sudden oscillatory discharges, using for this purpose high-tension transformers. These experiments have given the following results: the surface of a lightning conductor is as important as its cross-section. The ohmic resistance of the conductor is of little importance. Breaks in the continuity of the conductor are of small consequence. The self-induction of the conductor should be as small as possible. Induction between the lightning conductor and neighboring circuits may give rise to discharges in these circuits, and offer a resistance to the discharge of the main circuit. A house covered with a metal roof is analogous to a condenser, and may set up resonance phenomena. The following rules should be observed wherever possible: all lightning protective apparatus should be placed exterior to the building. The rod, the conductor and the ground plate should be placed in a straight line. The coefficient of self-induction should be sensibly zero. While it is not always possible to arrange the different parts of the lightning rod in a straight line, unnecessary bends should be avoided. M. Chavannes believes that, when the question has been studied thoroughly and the necessary conditions more fully understood, the real value of lightning rods will be recognized, and that, by means of them, the accidents due to atmospheric discharges will be greatly reduced.—*L'Electricien (Paris), April* 15.

The International Railway Congress.

Washington, D. C., May 3 to 13, 1905.

THE seventh session of the International Railway Congress was formerly opened at 11 A. M., May 4, 1905, at the New Willard Hotel, Washington, D. C. The Hon. Charles W. Fairbanks, vice-president of the United States, welcomed the members of the congress. The first delegate of the Belgian government, Mr. Ernest Gerard, acted as temporary president, and sat on the right of Mr. Fairbanks. At his left was Mr. Louis Weissenbruch, general secretary of the permanent commission.

In welcoming the delegates, Vice-President Fairbanks said that the railway was a mighty instrument of modern civilization. It was created to meet an imperative demand. It was created locally to meet local conditions, but it has extended until it binds together remote industrial centres. It has brought the capitals of the world nearer together. It has crossed and recrossed continents. It has become an artery over which passes the commerce of the world. It has been inextricably woven into the social, the commercial and the political affairs of millions and millions of the human race. Science and art, labor and capital have wrought a revolution. The work of construction and reconstruction is unending. The universal urgent and imperative demand has increased carrying capacity at a minimum cost of maintenance and operation. Hand in hand with this goes the demand for low rates of transportation.

The assembling of the International Railway Congress, he said, was of far-reaching moment. These sessions bring together into closer fellowship men of distinguished ability, representatives of many nations, interested in promoting a common and wholesome purpose.

Following the remarks of Vice-President Fairbanks, Mr. Ernest Gerard addressed the congress. Mr. Gerard said that it was twenty years since Belgium celebrated the fiftieth anniversary of the opening of the first public railway upon the continent of Europe. The road from Brussels to Malines was opened for business in 1835. To-day Belgium has a system of 4,552 kilometres of standard gauge road, and 2,722 kilometres of local railways. These systems operate through a territory of 29,455 square kilometres. This does not include the more than 500 kilometres of electric tramways now in operation in Belgium. The first six sessions of the congress took place in Europe, and the railways of the United States have, from session to session, played an increasingly important part. The great development of the roads of the United States, the wonderful rolling stock, the famous shops, the innumerable electric railways, with their powerful central power plants, are marked, in every case, by the very latest improvements.

Mr. Stuyvesant Fish then took the chair and delivered a brief address. On behalf of the American Railway Association, Mr. Fish welcomed the International Railway Congress. He recited some of the history of steam railway development, calling attention to the work of the early inventors in this field. Americans, he said, perceived from the very beginning the great importance of railways in the development of their country. As soon as they were put in possession of this marvelous implement, they covered their country with it. Since 1850 the United States has been among the first of the nations of the world in the extent of its railways.

At the close of Mr. Fish's address, the senior delegates nominated first by the governments represented, vice-presidents, *ex officio,* numbering twenty-nine, were requested to take their places. Mr. Fish thought that he was expressing the feelings of the meeting in asking Mr. Weissenbruch, general secretary of the permanent commission, to continue his functions as secretary-general of the seventh session. He proposed as associate-secretary-general Mr. W. F. Allen, secretary of the American section.

The congress was then invited to subdivide into sections, and the provisional presidents of the sections were announced as follows: first section, Mr. Stuyvesant Fish; second section, Mr. Theodore N. Ely; third section, Sir George Armytage; fourth section, Mr. Perouse; fifth section, Mr. Ernest Gerard. The first meeting adjourned at 12.45 P. M.

On May 5 the second section of the congress met at the New Willard Hotel, under the presidency of Mr. Ely. The section took up the discussion of "Locomotives and Rolling Stock." This meeting adjourned at noon.

Section 5, under the presidency of Mr. Ernest Gerard, met in the audience room of the Interstate Commerce Commission. The topic for discussion was "The Influence of Light Railways on Main Lines." The president of this section stated that tramways (street railways) are not included in the programme of the congress, and that there was, in Europe, a special congress for railways of that character. There is a great difference between large lines and tramway lines. Tramways start from large cities and run some distance into the country. Under these conditions, these lines compete, to some extent, with regular railways. The consequence is that large railway systems have no special inducement to favor the development of these tramways and railways of local interest.

Section 1 of the congress, under the presidency of Mr. Fish, met at the Ebbitt House. This section took up the subject of "Wooden Sleepers or Cross-Ties, Selection of Kinds of Woods and Processes of Preservation." Mr. Muntz, who presented the report, was of the opinion that special care should be taken with European woods. The pickling of sleepers in order to increase their life is to be generally recommended. The selection of the antiseptic and the method of carrying out the pickling operations depend upon individual conditions.

Section 3, under the presidency of Sir George Armytage, took up the discussion of "Baggage and Express Parcels." The reporter for all countries on the subject of baggage was Mr. George H. Daniels, general passenger agent of the New York Central & Hudson River Railroad Company. On the subject of express parcels, the reporter for all countries was Mr. J. H. Bradley, general traffic manager of the American Express Company.

On May 6 section 1 took up the discussion of the second conclusion of Mr. Kendrick's report on "Inspection and Preliminary Preparation before Treatment." This was under the heading of "Wooden Sleepers or Cross-Ties."

Mr. Cartault stated that the railways of the Paris, Lyons & Mediterranean Company use creosote treatment. The life of an oak tie is thereby increased to about fifteen or twenty years, and that of a beech tie from twenty-one to twenty-five years. The ties are first subjected to a vacuum in a metal tube, and then the creosote is injected under heavy pressure.

Upon the question of mechanical wear, Mr. Muntz said that the only way to secure a perfect fastening of the rails to the cross-ties is to make use of lag screws.

It is necessary to avoid the hammer upon the cross-ties produced by the passing of heavy loads over the track. When the surface of contact begins to wear, a piece of felt or soft wood should be put between the base of the rail and tie. When the holes made by the lag screws become too large, the Railway Company of the East (France) has a method of putting wooden plugs in the place where the screw is removed and boring new holes. This has given entire satisfaction.

Section 3 took up the discussion of "Suburban Traffic." The characteristic feature of this service is the necessity of handling a very large traffic, and making the necessary arrangements during a short period of time every morning and evening. The main points to be considered are: first, the number of passengers carried; second, the motive power; third, the train running speed; fourth, signals; fifth, station management. The conclusions from the report presented by Mr. A. J. Sullivan, general manager of the Missouri Pacific Railway, St. Louis, Mo., were as follows: to be in the highest degree remunerative, the traffic must be handled rapidly by simple and inexpensive means, and with the minimum working organization necessary for the purpose. The type of car is the essential factor. New lines to be constructed should be adapted to the best types of cars. On old lines, in order to utilize to the utmost the space between tracks, the curves should then be compensated to produce the same clearances as upon tangents. The locomotives should be sufficiently powerful to haul trains of maximum size at the speeds required. The train schedule should provide for the movement of all trains at a uniform speed, and stops at all stations upon the same tracks. Separate tracks should be provided upon lines of heavy traffic for trains which are to be run at high speed, and which do not stop at all stations. All necessary measures should be taken to accelerate the movement of passengers and start the trains promptly. In this way the expenditure of energy required to regain time lost is conserved, and the promptness with which the service is conducted communicates itself to the passengers, who quickly learn to move more rapidly. The frequency of train movements should be proportioned to the volume of traffic, to avoid prolonged waiting of passengers and congestion at stations.

Alexander Wilson, assistant general manager of the North Eastern Railway, England, stated that the North Eastern road had been operating for the past year a suburban service in the Newcastle district with electric power, with the object of regaining the traffic from the competing tramways and to increase its amount. Not all the traffic had been regained from the tramways, but the amount handled had been considerably increased. The reduction in expenses has resulted in a net revenue which more than covers the interest in the extra cost of installation necessitated by the introduction of the electric power. The current is furnished at a reasonable rate, by power stations which do not belong to the railroad.

A. Mange, secretary to the management of the Paris-Orleans Railroad, stated that the Paris-Orleans road operates electrically on 12.4 miles on the Paris-Juvisy line a hundred trains daily, instead of seventy-five as before the use of electric power. Four tracks are used—two for express trains, and two for locals. Trains are operated with reversible motors in front and behind. There are two types of trains—heavy trains of 286 tons and 1,000 seats, and light trains of seventy-three tons and 650 seats. The labor of one man was saved, the motorman alone fulfilling the duties of the fireman and engineer on the steam railroad.

Mr. Sullivan stated that installations have been made at the terminal station at Boston, underground, for a continuous circular service. Reversible motor trains like those of the Paris-Orleans road reduce considerably the time required at the terminal between the arrival and departure of trains.

Section 2 continued the discussion of "Locomotives and Rolling Stock." On Thursday, May 11, section 2 took up the discussion of question 8, "Electric Traction," which was debated conjointly with the fifth section.

On Wednesday, May 10, section 1 took up the discussion of "Improved Rail Crossings." On Thursday and Friday this section took up the discussion of "Concrete and Embedded Material."

On Monday, May 8, sections 2 and 3 together took up the question of "Lighting, Heating and Ventilation of Trains." On Tuesday, May 9, this section discussed "Pooling Locomotives." On Wednesday, May 10, the section discussed "Automatic Couplers."

On Thursday, May 4, the delegates were escorted to Mount Vernon. At 9 P. M. there was a reception by the trustees of the Corcoran Art Gallery, assisted by the commissioners of the District of Columbia. On Friday, May 5, Vice-President Fairbanks received the delegates at 2.30 P. M. On Saturday, May 6, the delegates visited the Capitol of the United States and the Congressional Library. On Monday, May 8, there was a reception of the foreign delegates by the German Embassy. On Tuesday, May 9, at 4 P. M., the delegates visited the New Union station, and at 7 P. M. attended the banquet tendered by the American Railway Association. On Wednesday, May 10, the delegates visited the arsenal and gunshop. On Thursday, May 11, visits were made to the Patent Office, the Pension Office and the National Museum. At 7 P. M. on Thursday the second part of the banquet tendered by the American Railway Association was celebrated. The programme for Friday, May 12, called for the entertainment of the delegates at 5 P. M. by Mrs. Roosevelt, and on Saturday, May 13, at 1.30 P. M., the general meeting and formal closing of the session; at 4.15 P. M., an excursion to Fort Meyer and Arlington.

The American Railway Appliance Exhibition.

At the annual meeting of the Railway Supply Men's Association, held in connection with the conventions of the Railway Master Mechanics and Master Car Builders' Associations, at Saratoga, N. Y., June, 1903, a resolution was adopted asking the officials of the American section of the congress if it would be agreeable to have an exhibition of American railway appliances in connection with the seventh session of the congress. A favorable reply was received, and Mr. George A. Post and Mr. J. Alexander Brown, respectively president and secretary of the Supply Men's Association at that time, presented to the executive committee of the American section a sketch of the proposed exhibition, which was approved. Upon a report to this effect to the appointing body at its annual meeting of June, 1904, Mr. Post was commissioned to select a committee representing, as completely as possible, the supply trade, as covered by the Supply Men's Association and the Road and Track Supplying Association, to the end that roadway, as well as mechanical supply trades, might be adequately represented. The members of this committee were announced in the last issue of the ELECTRICAL REVIEW. One of the greatest obstacles which this committee was confronted with at the outset was that there was no place in Wash-

ington where an exhibition could be held, except by act of Congress. Permissive legislation was therefore secured, and in January, 1905, an enabling act was passed by both houses of the national legislature. Not a single timber of the many substantial and handsome structures which now grace the Monument lot, where the exhibition is held, was erected until after March 20. The buildings which have since then been put in place represent an expenditure of about a million dollars.

The meeting in celebration of the opening of the American Railway Appliance Exhibition was called to order in the hall in the Monument lot at noon, May 3, by Mr. George A. Post, the chairman of the general committee of arrangements. In part, Mr. Post said:

"The American Railway Appliance Exhibition is an accomplished fact. Its portals are open. Its grand display of the products of more than 300 factories is ready for inspection, and the general committee of arrangements presents this magnificent scene of commercial activity as the result of the glorious cooperation of the American manufacturers in its labors in behalf of the great industry whose cheerful servant it has been. . . . This exhibition is a purely business proposition. Those who have brought their exhibits here from all parts of the country have done so in the fervent hope that they may attract the favorable attention of the railway officials who will be in attendance upon the International Railway Congress."

Mr. Post then presented the Hon. H. B. F. Macfarland, president of the Board of Commissioners of the District of Columbia, who delivered the address of welcome. Mr. Macfarland said that "but for the railroad and the telegraph the national capital would not have remained in the District of Columbia, but would have gone far west with the advancing march of population. The first public American railroad—the Baltimore & Ohio—came early to Washington. The first rail was laid on July 4, 1828. The first telegraph line ran from Washington to Baltimore. The first message was sent from the capital, and the first long-distance telephone line reached to Washington. The labors of Hercules and the wealth of Crœsus are surpassed by the marvelous achievements in transportation and communication in the short period of one lifetime. In the presence of the distinguished guests from abroad, delegates to the International Railway Congress, which we hope to see return at frequent intervals to hold its sessions here, we Americans do well to express our gratitude to the great men, living and dead, who have done so much in these fields for our new country."

Mr. Post, in a brief tribute to his achievements, introduced Mr. George Westinghouse as the speaker of the day. Mr. Westinghouse said, in part:

"It has been my privilege to know many of the great managers of railways in Europe as well as in the United States, and to learn to appreciate the magnificent work they have done in the development of railway transportation, and also to know and appreciate the skill, patience and self-sacrificing efforts put forth to ensure the comfort and safety of most exacting patrons, who, as a rule, have had but little opportunity to become acquainted with the difficulties surrounding those charged with the administration of our great railways. . . . A little error on the part of only one of the thousands of men employed upon a long line of railway which is traversed by a heavily laden train may have the most deplorable consequences, and therefore the infrequency of serious mistakes testifies unmistakably in favor of a most generous recognition of the reliability of the railway men, each of whom is apparently ever actuated in the discharge of his duties by an intense desire to guard the lives of his fellowmen who are even momentarily entrusted to his care.

"A new era of railway operations has dawned, with its many new problems. I refer to the growing use of electricity for the movement of trains. There have already been such demonstrations of the benefits to be derived from the substitution of the electric motor for the steam locomotive that it requires no great prophet to predict the extensive growth of electric traction upon the great railways, and the eventual replacement of the steam locomotive. Fortunately the time element, which is such a controller of events, and the financial problems involved, will ensure gradual development and extension of the use of electricity. With these changes have come vastly different engineering problems and new sources of danger which should, and will, command and receive that attention which is essential to the surmounting of every difficulty as it arises."

At the conclusion of his remarks, Mr. Westinghouse introduced, successively, Secretary Morton, Secretary Taft, the Hon. C. N. Lawrence, deputy chairman of the London & Northwestern Railway, and Mr. Stuyvesant Fish, president of the American Railway Association. Each of these gentlemen made a brief address.

At midnight on May 3 the delegates were entertained by a representation of the flash of a time signal around the world. This entertainment took place in Monument lot, and was under the direction of Rear-Admiral Chester, of the United States Navy. A large outline map of the world, forty-two feet long and twenty-four feet high, placed on a screen and fitted with 200 four-candle-power colored lamps, served to give a graphic demonstration. The map was prepared for this occasion by the hydrographic bureau of the Navy Department. The Western Union Telegraph Company and the Postal Telegraph-Cable Company had placed all their facilities at the disposal of the government. In addressing the delegates, Admiral Chester stated that, in spite of every effort, and especially in spite of the powerful influence of President Clowry, of the Western Union company, and of Vice-President and General Manager Ward, of the Postal company, he did not expect to be able to complete the world's circuit that night, because of the war raging in the far east. The electric lights were placed on the map, located in the positions of 200 of the principal cities of the world. Most of these received simultaneously the telegraphic signals. These 200 lights were merely typical of many thousands of others that might properly be added along the 500,000 miles of wire and cables over which the signals were flashed.

AMONG THE EXHIBITORS.

The Adams & Westlake Company, Chicago, Ill., is exhibiting the Newbold electric car-lighting system. In addition to this there are the Adlake gas car-lighting system, railway lanterns, down-draught signal lamps, car and shop hardware, and oil, gas and electric chandeliers. The company is represented by E. L. Langworthy, A. S. Anderson, F. N. Grigg, R. M. Newbold, and William S. Hamm.

The Anglo-American Varnish Company, Newark, N. J., is represented by William Marshall and George M. Ballard.

Harold P. Brown, New York, is exhibiting electric rail bonds, rail drills, hand-power grinders and instantaneous soldering and brazing processes.

The Bryant Electric Company, Bridgeport, Ct., is located in the Westinghouse building, and is exhibiting standard electrical fittings and hardware.

The Cling-Surface Company, Buffalo, N. Y., is exhibiting its "Cling-Surface"

for belts and ropes. Represented by William D. Young and J. B. Faatz.

The Consolidated Car-Heating Company, Albany, N. Y., is exhibiting electric heaters for all classes of electric car service, with regulating switches, and the McElroy automatic axle-lighting system in operation. Represented by Francis C. Green, Cornell S. Hawley, James F. McElroy and William H. Fulton.

The Consolidated Railway, Electric Lighting and Equipment Company, New York city, has on exhibition a standard truck equipped with its system of axle-car lighting, together with switchboards and regulators. Represented by John P. Dickinson, P. Kennedy, Thomas Mount, J. Dorman and W. M. Lawlor.

The Continuous Rail Joint Company of America, Newark, N. J., is exhibiting various forms of rail joints with a special electric bonding, and joints showing the use of all types of bonds. Represented by E. F. Braine, B. M. Barr, V. C. Armstrong, W. Clark and E. A. Condit, Jr.

The Edison Manufacturing Company, New York, is exhibiting Edison primary batteries for railway work. Represented by W. S. Logue and G. A. Guyer.

The Electric Controller and Supply Company, Cleveland, Ohio, is exhibiting the Deutsch electric train-lighting system. Represented by Isadore Deutsch and W. W. Adams.

The Electric Storage Battery Company, Philadelphia, Pa., is exhibiting the chloride accumulator used in connection with the electrification of steam roads, storage battery switchboards, portable and stationary cells, cells for train lighting, recording apparatus, and storage battery auxiliaries. Represented by E. L. Reynolds and W. G. Davis.

The Electro-Dynamic Company, Bayonne, N. J., is exhibiting a number of different sizes of its "Interpole" variable-speed and constant-speed motors. Represented by G. H. Condict and H. McL. Harding.

The General Electric Company, Schenectady, N. Y., has on exhibition a multiple-unit train control, various types of railway motors, the Curtis steam turbine, combination automatic-straight air-brake compressor, and automatic electric signals. In addition to this are moving pictures of electric locomotives; and the application of the mercury arc rectifier is demonstrated. Represented by General Eugene Griffin, E. W. Rice, Jr., J. R. Lovejoy, J. R. McKee, William J. Clark, L. R. Pomeroy, W. B. Potter, A. H. Armstrong, J. G. Barry and F. H. Gale.

The General Railway Signal Company, Buffalo, N. Y., is exhibiting electric, mechanical and low-pressure pneumatic, interlocking electric automatic block signals, and manually controlled block signals.

The Gold Car Heating and Lighting Company, New York city, has on exhibition its car heating and lighting apparatus. Represented by E. E. Gold, John E. Ward, W. E. Banks, B. H. Hawkins, A. E. Robbins, W. H. Stocks and Richard Voges.

The Gould Coupler Company, New York, is exhibiting its electric car-lighting system, together with other specialties. Represented by T. L. McKeen, M. H. Shedd, F. P. Huntley, W. R. Turbayne.

The Hall Signal Company, New York, electric motor signal, electro-gas signal, staff signal apparatus, lightning arresters, electroliquid slot signal, disk signals and indicators, and semaphore indicators. Represented by A. J. Wilson, E. N. Godman and Dixon Boardman.

The International Correspondence Schools, Scranton, Pa., are exhibiting text-books for instruction. Represented by W. N. Mitchell, E. M. Sawyer and L. A. Osborne.

The H. W. Johns-Manville Company, New York, asbestos and magnesia materials. Represented by J. E. Meek and J. R. Younglove.

Kinsman Block Signal System Company, New York, exhibiting the Kinsman block system. Represented by Frank E. Kinsman and W. E. Meschenmoser.

The Lunkenheimer Company, Cincinnati, Ohio, is exhibiting valves of various types and other locomotive fittings. Represented by S. S. Moyer, William Schmidt, Jr., and W. M. Hood.

The Spaulding Print Paper Company, Boston, Mass., is exhibiting the Federal electric blue-printing apparatus. Represented by Charles Spaulding.

The Robins Conveying Belt Company, New York, has on exhibition a working model of a sixteen-inch conveyer, showing dischargers, automatic reversible tripper and different angles of working. Represented by A. B. Brool, Jr., E. S. Stadelman and Thomas Robins.

The Sprague Electric Company, New York, has on exhibition the Sprague electric hoist and the Sprague flexible steel-armored hose for steam and compressed air. Represented by A. C. Bakewell, E. H. Watlington and G. C. Conner.

The Standard Paint Company, New York, has on exhibition its "Ruberoid" covering for locomotive house roofing. Represented by Ralph N. Shainwald, J. N. Richards and Paul M. Wade.

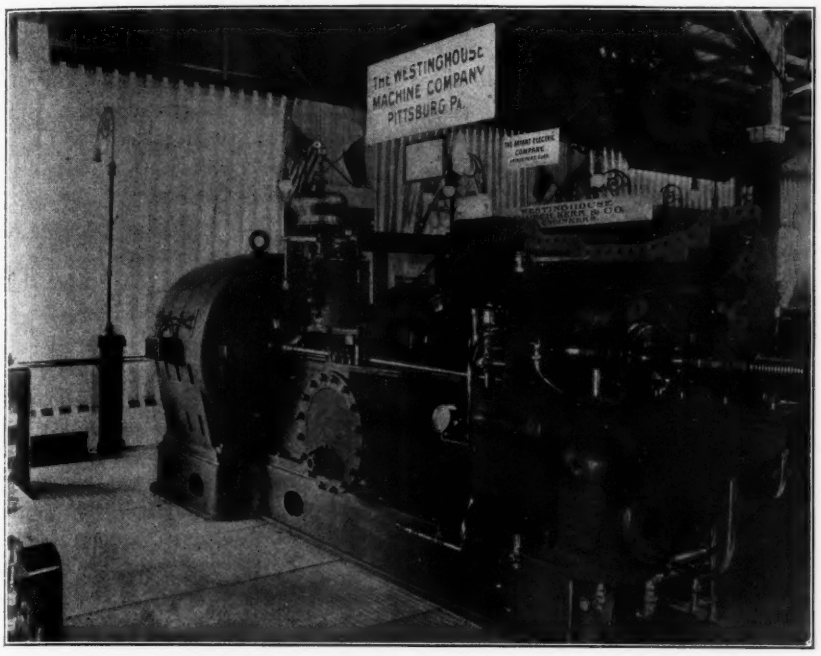
The United States Lighting and Heating Company, New York, has on exhibition a four-wheel truck showing in operation its axle-lighting system. This system was inspected by many of the railroad men. Represented by A. S. Adler, H. K. Brooks and Morris Moscowitz.

The Westinghouse building at Washington is the largest structure on the grounds, apart from the headquarters building devoted to the grouped displays of the smaller exhibitions. It presents a remarkable combination of Westinghouse products.

The brake and coupler pavilion display includes many operative exhibits. The Westinghouse automatic air and steam coupler is demonstrated by an arrangement of two short car platforms modeled to represent the ends of passengers and freight cars, together with a locomotive pilot, one car platform being so mounted as to permit a variation of four inches in its height and a propulsion at a considerable momentum toward either the pilot on one end or the other car platform on the other, provision being made also for the illustration of successful hose coupling at extreme curves. The model is operated with compressed air and the hose lines are supplied with both air and steam pressure. A miniature model of two complete car trucks and frames fitted with air and steam and signal hose coupling and air cylinders supplement the heavy exhibit, and both are in more or less constant operation. The Westinghouse magnetic brake is shown in operation by an arrangement of a moving track; the Westinghouse friction draught gear is displayed on a testing rack on which it is compressed with an air force of approximately 150,000 pounds, a slow and serial release without recoil demonstrating a feature of prime importance in its operation; and the locomotive driver brakes and the automatic slack adjusters of the American Brake Company; racks hung with valves of various forms shown in sections, and several types of motor-driven and steam air compressors complete the display. The operation of Westinghouse air brakes is completely illustrated in the "instruction car" of the Brake Company on the special track at B and Fourteenth streets, in charge of the company's regular instruction corps.

The most important feature of the electric traction exhibit is a fifty-foot dummy car platform completely equipped with Westinghouse single-phase motors and "straight-air" brakes, and with the West-

inghouse unit system of multiple control as designed for alternating-current practice, with induction regulators by means of which a variable operating voltage is



600-Horse-Power, Westinghouse-Parsons Steam Turbine, Open for Inspection, Westinghouse Companies Exhibit, American Railway Appliance Exhibition.

secured to provide a wide range of speed without resistance losses. The motors are of type No. 106, 100 horse-power capacity,

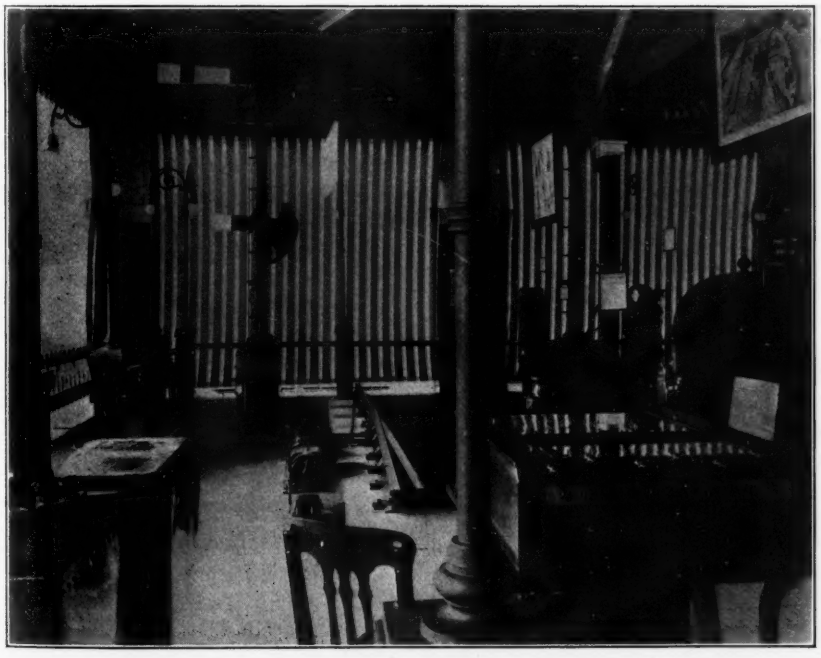
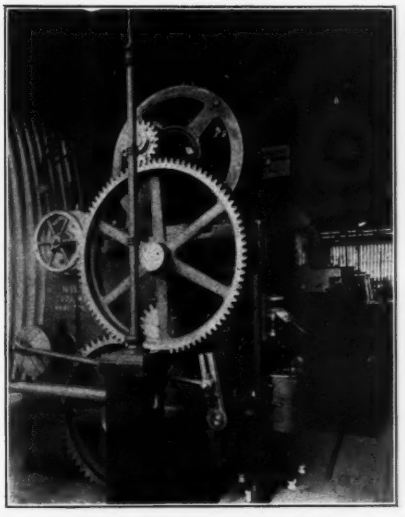


Exhibit of the Union Switch and Signal Company, Westinghouse Companies at the American Railway Appliance Exhibition.

two on each truck, and the master controller and brake operating valve are mounted at each end of the platform as in the motorman's cab, the entire car frame being so raised above elevated tracks as to permit the revolution of the wheels under slight frictional pressure on greased rails to keep the motors under load.

The latest form of Westinghouse multiple control for direct-current practice is demonstrated in the complete car equipment for the operation of a truck driven by two No. 113 motors, each of 200-horse-power capacity, a type embodying slight modifications of motor No. 86 for heavy train service on the Long Island Railroad.

The motor-driven tools on exhibit are all equipped with type S shunt-wound motors, for constant-speed or variable-speed service, and for operation on direct-current circuits at 220 volts. The prominent feature of this display is a large locomotive driving wheel lathe weighing over 100,000 pounds, built at the Ohio works of the Niles-Bement-Pond Company, equipped with a forty-horse-power motor mounted at the top and direct-geared to the revolving and feed mechanism, and with a five-horse-power motor of 1,050 revolutions per minute, for traversing the movable head. The face-plates of the lathe are mortised to receive the crank-pins, thus permitting the "chucking" of the wheels close to the plates, the absolutely rigid hold on the tires under the heaviest cuts greatly facilitating the operation of the machine, which has a capacity of truing six pairs of driving-wheel tires in a ten-hour day. Another Niles machine on exhibit is a double-axle lathe, driven by a twenty-horse-power motor of from 340 to 1,200 revolutions a minute, mounted on an extension to the bed-plate and gear-connected to the mechanism, the machine having a total cutting diameter of twelve and one-half inches. Other tools on exhibit are a Putnam roughing lathe driven by a fifty-horse-power motor of from 500 to 1,000 revolutions a minute; and a Sellers universal tool grinder, driven by a seven and one-half-horse-power motor of 975 revolutions a minute, mounted on a bed-plate extension, and belt-connected to the driving shaft.



Gear Drive of Forty-Horse-Power Motor on Niles Ninety-Inch Locomotive Driver Lathe, Westinghouse Companies Exhibit, American Railway Appliance Exhibition.

The National Electric Light Association.

The following programme is announced for the twenty-eighth convention of the National Electric Light Association, to be held at Denver and Colorado Springs from June 5 to 13 inclusive.

Monday, June 5—Arrival of delegates. Reception of local committee. Informal reception with music at headquarters, the Brown Palace Hotel.

Tuesday, June 6—Morning: business session in ordinary of Brown Hotel. Addresses of welcome by Governor Jesse F. McDonald, Mayor Speer, of Denver, and Mayor Hall, of Colorado Springs.

Afternoon: business session. Country Club luncheon for ladies.

Evening: theatre party at Elitch's Gardens.

Wednesday, June 7—Morning: business session.

Afternoon: Broncho-busting contest at D. A. C. Park.

Evening: business session until 10 P. M. At 10.30 P. M. an "athletic" smoker at either the Democratic Club or Coliseum Hall. Party at Orpheum for the ladies (if theatre is open).

Thursday, June 8—Morning: business session.

Afternoon: business session. Street-car rides for the ladies.

Evening: business session. Serenade by the George W. Cook drum corps.

Friday, June 9—Morning: entire party transported to Colorado Springs.

Afternoon: at Colorado Springs—drives to all of the famous scenic points. Visits to the power plants. Trips up Pike's Peak.

Evening: dance and concert at the Broadmoor Casino.

Saturday, June 10—All day; special trains to the Cripple Creek District and return.

Sunday, June 11—All day: trips to the scenic points about Colorado Springs, each delegate taking those he was unable to take on Friday.

Monday and Tuesday will be devoted to excursion parties arranged for those desiring to go over the Moffat Road and the Loop.

The business meetings will be held in the ballroom of the Brown Palace Hotel, beginning the morning of June 6. The business of the convention should be over by the night of June 8. Low rates for the convention have been obtained.

Those arranging to attend the convention and securing railroad tickets reading over the Union Pacific, Burlington or Rock Island systems should have their tickets read to Colorado Springs through Denver, with stop-over at Denver. This arrangement has been agreed to by the roads. On the Santa Fé and Missouri Pacific systems the tickets should read through Colorado Springs to Denver, with stop-over at Colorado Springs returning.

The committee in charge of the convention plans promises a programme of entertainment which will eclipse anything heretofore held. For the entertainment of the womenfolk who attend the convention, the Women's Auxiliary and the members of the Denver Country Club are making extensive preparations.

Arrangements have been made to run a special train of Pullman cars from New York to Denver *via* the Pennsylvania line and Burlington route, leaving New York Saturday, June 3, and arriving at Denver, Monday, June 5. This train will be a duplicate of the Pennsylvania Limited. Electrically lighted parlor, smoker, dining and observation cars will be run *via* Chicago, at which point it will be consolidated with a similar train being made up for the accommodation of western delegates.

The Pennsylvania Railroad has been made the official railroad to be used as far as Chicago, while the C. B. & Q., known as the Burlington route, has been made official and has been given the special train from Chicago to Denver, to operate in conjunction with the Pennsylvania Railroad special, and haul the latter train coupled to its own from Chicago to Denver.

The train will proceed westward through Harrisburg, arriving at Fort Wayne on the morning of June 4. The train will probably reach Chicago the same forenoon. Western passengers to the convention should plan to be in Chicago Sunday morning, June 4. The cost of round-trip tickets and of sleeping-car berths from Chicago to Denver will be as follows: round-trip fare, Chicago to Denver, *via* the Burlington route, $30; lower berth, one way, $6; upper berth, $6; drawing-rooms, $21.

Application for space should be made early, as the lower berths are limited, to Mr. George F. Porter, master of transportation, 136 Liberty street, New York city; or to Mr. Colin Studds, eastern passenger agent Pennsylvania Railroad, 263 Fifth avenue, New York city.

An elaborate programme has been prepared for the business sessions, the following numbers being now in hand:

Wrinkles, H. C. Abell, editor.

Question Box, Homer E. Niesz, editor.

"The Nernst Lamp, Its Present Performance and Commercial Status," by E. R. Roberts.

"Report on Purchased Electric Power in Factories," by E. W. Lloyd, chairman.

"Report on Present Method of Protection from Lightning and Other Static Disturbances," by Alex Dow.

"Some Investigation of Inductive Losses," by E. P. Dillon.

"Insulation Testing Apparatus and Methods," by C. E. Skinner.

"The Choice of an Insulated Cable," by Wallace S. Clark.

"Sign and Decorative Lighting," by LaRue Vredenburgh.

"Automatic Synchronizing of Generators and Rotaries," by Paul MacGahan.

"Series Alternating-Current Motors for Industrial Work," by Clarence Renshaw.

"Long-Distance High-Tension Transmission in California," by John A. Britton.

"Report of the Committee on Progress," by T. Commerford Martin.

Annual Meeting of the American Institute of Electrical Engineers.

The 197th and annual meeting of the American Institute of Electrical Engineers will be held in the chapter room of Carnegie Hall, 154 West Fifty-seventh street, on Tuesday evening, May 16, at 8.15 o'clock. The result of the recent election for officers of the Institute will be announced, and the secretary and treasurer will present their annual reports. The following papers will then be presented and discussed:

1. "Time-Limit Relays," by George F. Chellis, associate, American Institute of Electrical Engineers; Interborough Rapid Transit Company, New York.

2. "The Proper Limit of Duplication to Secure Reliability of Service," by H. W. Buck, member American Institute of Electrical Engineers; Niagara Falls Power Company, Niagara Falls, N. Y.

Dinner of the Indianapolis Telephone Company.

The New Telephone Company, the New Long-Distance Telephone Company and the Indianapolis Telephone Company held a dinner at the German House, Indianapolis, Ind., on Wednesday evening, May 10. The dinner was to celebrate the sixth anniversary of the opening for business of the New Telephone Company and the New Long-Distance Telephone Company.

THE MERCURY ARC.[1]

BY E. WEINTRAUB, PH. D.

INTRODUCTION.

This paper contains results of an investigation on the properties and nature of the conductivity of metallic vapors carried out in the research laboratory of the General Electric Company. The investigation was started with the practical purpose in view of using the arc discharge in metallic vapors, and especially mercury vapors, as a source of light. The principal practical problems to be determined at the time the investigation was begun (more than four years ago) were as follows:

1. The starting of the discharge in metallic vapors in an instantaneous and automatic way by the current itself.

2. The determination of conditions under which an alternating voltage can be made to maintain an arc in metallic vapors.

3. Determination of the factors influencing the stability of the arc, with the purpose of constructing a lamp stable under varying external conditions.

4. The production of an arc of the character named which would emit rays belonging to different spectral regions in such proportions as to constitute white light.

None of these problems could be solved on the basis of the knowledge then available, and pure theoretical investigations had to precede any attempt of their solution.

STARTING AN ARC IN METALLIC VAPORS.

The Rôle of the Cathode in the Starting Process—The distinctive feature of the conductivity of gases and metallic vapors, in contradistinction to that of metals and electrolytes, consists in that under ordinary conditions, in absence of exterior ionizing agents, the current itself has to create the material which is to carry it from one electrode to the other. As this material does not exist at the beginning, some special means must be used to start the discharge. Two different ways were used to start the arc discharge. The first one consists in bringing the two electrodes into contact and then separating them. This method is exactly the same as the one used in the carbon arc, the flame arc, etc. The second one is founded on the use of a high-voltage shock.

The new way of starting an arc discharge in mercury vapor that I want to expound here was the outcome of the theoretical conceptions on the mechanism of the arc and the function of the ionization at the cathode surface that I formed in the course of these investigations. According to these conceptions, an arc discharge in metallic vapors is a discharge deriving its carriers, at least in the immediate neighborhood of the cathode, from the material of that cathode. The application of a moderate electromotive force is of itself insufficient to start the process by which these carriers are formed out of the material of the cathode. The new fact discovered was that this formation of carriers (the "ionization" process) is started and the arc discharge made possible if a spark or a small arc is produced at the surface of the cathode.

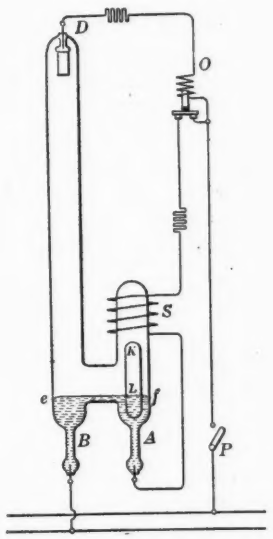


FIG. 1.—ARRANGEMENT FOR SEPARATING ELECTRODES.

For the practical use of this starting method the operations of separating the electrodes and discontinuing the auxiliary arc the moment the main arc is started must be performed automatically by the current itself. One of the arrangements that I have devised is represented in Fig. 1. KL is an iron plunger, S a solenoid and O a magnetic cutout. The solenoid S, in pulling up the plunger KL, produces the auxiliary arc. The current in the main arc flows through the magnetic cutout and automatically opens the circuit of the auxiliary arc.

As a development of the old contact method I have used the following way, which is based on the use of a carbon filament of high resistance which first establishes connections between the anode and cathode, so that on closing the switch the current first flows through the filament. By means of a solenoid and its magnetic action on an iron plunger the filament is lifted and the contact between its lower end and the mercury cathode broken. Exactly as in the case of the old form of contact method the small arc lengthens until the carbon filament is short-circuited by the arc.

Influence of the Conditions Prevailing in the Space between the Electrodes on the Starting Process—The space separating the electrodes has an important influence on the velocity with which the starting takes place, but this influence is mainly of a negative character. The space must present as little hindrance as possible to the flow of ions starting from the cathode surface. Accordingly, the degree of vacuum must be the highest obtainable, and the more careful the exhaustion the more instantaneous is the starting. If foreign gases or inert ordinary mercury vapor is present, the starting is slow. The ionized vapor is seen to rise from the surface of the cathode and slowly move along the tube, impeded in its course not only by the gases present in the tube, but also by the mercury vapor which volatilizes from the heated surface of the mercury cathode. When the vapor reaches the anode the arc will eventually start, but if the pressure of the foreign gases is high enough the arc does not establish itself at all. Although it is relatively easy to produce the high vacuum necessary for the instantaneous starting, it is not easy to drive out completely the gases absorbed on the walls of the tube and in the anode material. The vacuum in the lamps is liable, in some cases, to get worse with use, and some means had to be provided which would render the starting of the arc instantaneous, even with a somewhat impaired vacuum pressure of foreign gases above 0.01 millimetre. As inert mercury vapor also hinders the propagation of the ionized vapor, even perfectly exhausted lamps start harder when hot than when cold. I found that the propagation of ions and the starting of the arc are facilitated if a carbon filament of high resistance is suspended from the anode in such a way that its lower end is distant but a few inches from the mercury surface. When the ionic stream reaches the lower end of the filament a small current is established which helps the starting of the main arc.

Function of the Anode in the Starting Process—In contradistinction to the cathode the anode plays no rôle whatever in the starting process. It receives the carriers of the current without any previous excitation.

CONDITIONS OF STABILITY OF THE ARC.

The Influence of the Conditions at the Cathode Surface—In the study of the

[1] Abstract of a paper read at the seventh general meeting of the American Electrochemical Society, Boston, Mass., April 25, 26, 27, 1905

conditions of the mercury arc one meets with a phenomenon which is being observed in all arcs, *i. e.*, the existence at each impressed voltage of a lower limit of current, below which the arc is not stable and extinguishes. The experiments performed on the mercury arc led me to the conclusion that the physical cause of it is in the conditions prevailing at the very surface of the cathode. Under ordinary circumstances there is a bright spot on the surface of the mercury cathode, which spot is continually wandering about on that surface. The wandering of this spot has not found as yet any very satisfactory explanation. The spot is, according to the conceptions expounded here, the place where the production of ions takes place, and the continuous motion of that spot means a disturbance of the ionization process and a danger to the existence of the arc. The wandering of the spot can be avoided in two different ways: either by making the surface of the cathode small, of the same magnitude as that of the spot, or by having a wire of iron or platinum project above the surface of the mercury. In this latter case the cathode spot is centered on the mercury surface right around the metallic wire. In order to limit the surface of the cathode, without changing anything else in the tube, narrow tubes of refractory material, such as silica or porcelain, are fastened inside of the mercury cathode. The arc is started by means of a carbon filament which dips into that small tube. The filament is lifted by the passage of the current, the current broken and the little spark produced inside of the narrow tube. The rest of the mercury surface outside of the small tube is then inert and does not carry any current. This is, by the way, an experiment showing strikingly that the arc has its root in the cathode spot.

Both methods lead to the same result, the lowering of the minimum current at which the arc subsists. With 120 volts applied and about eighty volts consumed by the arc, the low limit of current is normally at about three amperes. When the cathode surface is made very small this limit decreases to 1.5 amperes, and with a platinum wire it becomes as low as one ampere. These values can be made much smaller if reactance is placed in the circuit or if the impressed voltage is higher.

Influence of the Conditions Prevailing in the Space between the Electrodes on the Stability of the Arc—The conductivity of the arc depends on the relative amounts of ionized and inert mercury vapor. If a sufficient condensing space is provided, so that the pressure of the ordinary mercury vapor volatilized from the cathode is kept down to a certain value, the conductivity of the arc is almost exactly proportional to the current. (The current creates its own ions: Ohm's law is applicable.) The voltage across the arc is accordingly almost independent of the current. If, however, sufficient condensing space is not provided the amount of inert mercury vapor rises continually, and

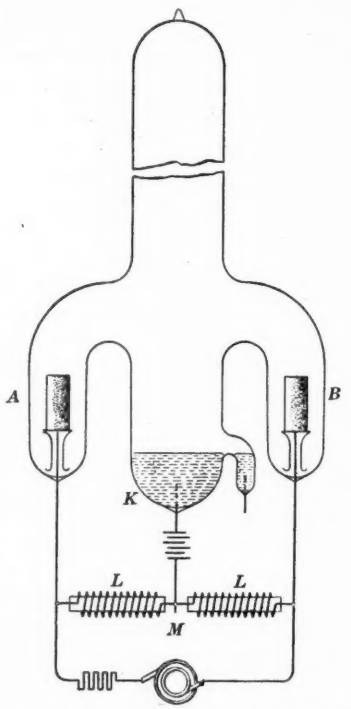


FIG. 2.—ARRANGEMENT FOR CAUSING TWO HALVES OF CURRENT WAVE TO PASS THROUGH ARC.

with it the resistance of and voltage across the arc, until finally, when the voltage across the arc comes too near to the impressed voltage, the arc goes out. Foreign gases present in the tube have influence similar to, and even more pronounced than that of mercury vapor.

The statements above give a complete description of the influence of the conditions prevailing in the arc itself on its stability. They have no noticeable effect on the value of the lower limit of current.

Influence of the Conditions at the Anode—The conditions prevailing at the surface of the anode have no appreciable effect on the stability of the arc. If the anode is made of mercury, great amounts of mercury vaporize because of the heat generated at the anode. This increases the amount of mercury vapor in the arc, and thus indirectly changes the conditions of stability of the latter. This is obviously a secondary effect; otherwise, the anode has just as little effect on the stability of the arc as it has on the starting process.

THE ALTERNATING-CURRENT ARC IN METALLIC VAPORS.

We have seen in the preceding chapters that the ionization process at the cathode must be initiated if an arc discharge in metallic vapors is to be established, and that this ionization process must be kept up by the supply of a certain amount of energy if the arc is to maintain itself. It is in these facts that lies the explanation of the difficulty that previous investigators have found in maintaining an alternating-current arc through metallic vapors. With every change of polarity the ionization process at the cathode dies out and moderate electromotive forces are insufficient to start that process by themselves on the surface of the other electrode when the latter becomes of negative sign. It is therefore obvious that if an alternating electromotive force of moderate value is to maintain an arc in metallic vapors, one metallic electrode must permanently keep its negative sign, notwithstanding the perpetual change of polarity. This, if realized, would mean a unidirectional flow of current in the arc, and consequently rectification of the alternating current.

Of all the devices used by me I mention but two. In both of them the tube contains three electrodes, one of mercury, the others of graphite, iron or mercury. The one electrode of mercury serves as the cathode, the two others, which we will suppose to be made of graphite, serve as anodes of the rectified arcs. In the first arrangement a transformer is used, the ends of the secondary of which are connected to the two graphite anodes. A wire taken out from the middle of the secondary is connected to the cathode. The current derived is pulsating, and if the rectified voltage or current is low, usually a small direct-current arc, springing from the same cathode, is necessary to keep the cathode alive during the zero point of the current. If a constant-current transformer is used this direct-current arc can be dispensed with.

In the second method the alternating voltage is directly applied to the two graphite electrodes and two reactance coils are connected in the way shown in Fig. 2. As in the first arrangement, two arcs are playing in the tube, both having the same cathode. The reactances store up

energy, while the current flowing in them increases and discharges through the arc in such a direction as to keep the cathode K alive. By means of arrangements of this kind I succeeded in rectifying voltages up to 15,000, giving direct-current voltage as high as 6,000 to 7,000 volts. This last arrangement may become of importance, even for laboratory use, when unidirectional high voltage is desired.

ARC DISCHARGE IN VAPORS OF ALKALI METALS.

With the purpose of adding red lines to the spectrum of the mercury arc I investigated the arc discharge in vapors of other more or less volatile metals. Alkali metals proved especially suitable. The experiments showed that the regularities found during the study of the discharge in mercury vapors hold good for all other metallic vapors. The cathode phenomena, the bright cathode spot, the behavior toward alternating voltage are exactly the same. Accordingly, all of the experimental facts established for mercury vapor hold good for the discharge in metallic vapors in general.

ON THE MECHANISM OF THE IONIZATION PROCESS AT THE CATHODE.

An insight into the mechanism of these processes would give us a basis to the theory of the arc discharge, and of the conductivity of gases in general. The first question I tried to answer by experiments was, whether the ionization process at the cathode is accompanied by an actual transfer of matter or not. To simplify conditions a graphite anode was used in all the experiments. In this case the mercury distills over in great quantities from the cathode into the condensing space surrounding the anode. This mercury is, however, in the greatest part produced by mere volatilization of the cathode. If the mercury cathode is cooled artificially, so that the heat generated is conducted rapidly away, the amount of the condensed mercury diminishes considerably, and if the wandering of the cathode spot is avoided by the projecting wire method this amount is still further diminished. The amount of mercury that condenses under these conditions in the condensing chamber surrounding the anode is very small and constitutes but a small part of the amount required by Faraday's law. The largest part of it is, however, still due to mere volatilization which can not be completely avoided.

An attempt was made to get quantitative data by using mercury arcs with cathodes made of less volatile material than mercury. If a piece of graphite or any other conducting material that does not combine with mercury, and a mercury cup, both enclosed in an exhausted tube, are connected to respectively the negative and positive pole of a source of an electromotive force, the electrodes brought into electrical contact and separated, an arc is formed with the solid electrode as cathode. The behavior of these solid cathodes is the same as that of the mercury cathode. A bright spot is wandering on the surface of the solid piece and wherever that spot strikes the cathode disintegration of its material takes place. This disintegration is characteristic of the cathode of a metallic arc in an exhausted space. If a piece of charcoal is used as a cathode the motion of the cathode spot leaves fine lines and grooves burned, so to say, into the material. The loss of weight of these solid cathodes is usually very small. The largest part of it is, however, due to the mechanical disintegration of the material which accompanies the electrical one, which circumstance deprives the result of theoretical significance. We can, therefore, conclude from these experiments that a transfer of matter either does not take place at all, or is so small as to be of the order of magnitude that would be required by the value of the electronic mass accepted in the modern theories.

The second question of special interest in connection with the theory of the arc refers to the cause of the ionization process at the cathode. The formation of current-bearing particles does not in all probability take place at all in the arc itself. The potential drop in the arc and that at the cathode surface (about five volts) are so small that productions of ions by collision seem to be excluded. As the anode plays no appreciable rôle during the starting and the running of the arc we are led to the conclusion that in an arc through metallic vapors in an exhausted space the cathode is the only place where the current-bearing material is formed.

The assumption that the cathode is one of the places where ionization takes place has been made by many previous investigators. In view of the fact that solid bodies heated to a high temperature are known to render gases conductive (effect that I observed myself in the case of mercury vapor), the ionization process at the cathode was attributed by some of the investigators to the high temperature prevailing at the cathode. The experience that I have had on arcs in metallic vapors, and special experiments made to elucidate this point, do not support this view. The boiling point of mercury being low, it is necessary, of course, to limit the supposed area of high temperature to the cathode spot itself.

The facts that speak against this assumption are as follows: first, as mentioned above, the cathode spot moves rapidly along the surface of the cathode. If high temperature were a necessary condition of the ionization process the cathode spot would not be expected to move constantly away from the exceedingly hot part to the cold part of the surface. Second, if a spot is fixed by means of a platinum wire no evidence of a high temperature in that spot can be found. The faint light emitted by the spot surrounding the wire reminds one, especially when the current is not very high, rather of a phosphorescent light than of light produced by high temperature. Third, efficient cooling of the cathode does not produce any change, either in the cathode spot or in the arc. Fourth, if solid cathodes, such as graphite, iron, platinum, etc., are used, the cathode spot on the surface, to judge by its color, has not a very high temperature, so that the rapid disintegration is not due to volatilization by heat, but rather to purely electrical causes. If, by an auxiliary current, the solid cathode is heated up in such a way that one part of it, by reason of its higher resistance, is brought to a very high temperature, the cathode spot wanders about the surface of the cathode without showing any preference for the hot spot, which would be expected if high temperature were the cause of ionization.

Fifth: in the case of an "arcing" rectifier, where we have to deal with the formation of the cathode spot, temperature of the solid electrodes plays but an unimportant rôle. The electrodes may be very hot while surrounded by ionized vapor without causing arcing. This is very significant if compared with the relative ease with which at first sight seemingly unimportant factors produce arcing. If, for instance, the electrodes are of mercury, a drop of mercury hitting the surface, or any other mechanical disturbance, is liable to produce a cathode at the point where impact takes place. These and a number of other facts, for which I have not space here, led me to the conclusion that the temperature of the cathode is not the cause of ionization in the case of metallic arcs in an exhausted space. The temperature of the cathode is probably in some way connected with the boiling point of its material and is a result of the ionization process rather than the cause of it. The

facts quoted above are not, of course, intended to disprove the influence of high temperature on ionization, which is too well proven in other cases. In arcs in metallic vapors considered here, the temperature of the cathode does not seem to be the ionizing agent.

The time has not yet come to give a complete theory of the arc. In working for years with the mercury arc I had, however, to make for my own use some working hypothesis, and as this hypothesis seems to agree with all the facts that I have observed and was helpful to me in the course of my investigation, I will outline it here briefly, without, however, trying to give in detail its justification, as this would require an article for itself. In some points, this hypothesis agrees with the views of previous investigators, in some others it differs.

Starting from the hypothesis developed by a number of modern scientists, according to which the conduction in metals is due mostly to the negative electrons, and from the postulate that the mechanism of conduction in different states of matter must have the same general characteristics, I assume that the mechanism of the conduction in the arc is similar to that in metals and that an arc is, electrically considered, in the main a flow of negative electrons directed from the cathode toward the anode. While in the metal the number of electrons is a given quantity and the conductivity accordingly constant, the number of electrons crossing the surface of the cathode and entering into the arc must be proportional to the current. Accordingly, the conductivity of the arc is proportional to the current. The process of starting an arc serves to initiate the process by which the electrons are driven out from the metal into the space. The starting is probably reduced by purely electrical causes. If this process, by means of which the negative electrons are projected out of the metallic mass is started, it goes on of itself so long as a sufficient amount of energy is applied. The disintegration of the cathode is a mechanical accompaniment of this electrical process.

The light emitted by the arc is not due directly to the radiation of the electrons. These negative electrons are probably the same in all arcs, and the light emitted changes according to the molecular material through which these electrons move.

The quarterly report of the National Board of Fire Underwriters shows 134 fires due to electricity with a loss of $855,000. Losses of $1,482,000, due to 193 other fires are reported, whose origin was believed to be due to electricity, but where the fire destroyed proof of the origin.

THE TELEPHONE SYSTEM OF TO-DAY.[1]

BY C. J. H. WOODBURY.

The telephone differs from all other electrical devices in that it is the only electrical appliance which does not require skill on the part of its users. It is equally the servant of all, a polyglot, it speaks all languages and acts as a faithful messenger for the whole gamut of sounds.

ADMINISTRATION OF THE TELEPHONE SYSTEM.

The telephone would have remained a piece of physical apparatus, an example of the correlation of forces, an instrument to aid in the study of sound, and a wonder to all had it not been for the production of the switchboard, and particularly of the Blake transmitter, which saved the situation in the development of the telephone system.

It was indeed fortunate for the world's work that the organization of the telephone system from its inception was in the hands of leaders equal to the task of concentrating the labors of many persons upon the sole purpose of furnishing practical operative conditions for the transmission of speech as a public service enterprise.

Its first president, Colonel William H. Forbes, was endowed with wisdom to plan and vigor to execute these duties, in the spirit of imagination to foresee future possibilities, combined with a knowledge of present events which he shaped to existing conditions.

To John E. Hudson, an eminent member of the bar, were largely due the measures which established the system in its strong legal position, and to him also is due in large measure its development as a great national enterprise.

The present executive of the American Telephone and Telegraph Company, Frederick P. Fish, was for many years its counsel in the complex causes of patent litigation, and it has been under his administration that the recent growth of the telephone system has surpassed that of earlier years.

The work of these men has been executed by faithful lieutenants from the greatest unto the least in this army of seventy-five thousand unseen toilers.

THE TELEPHONE CIRCUIT.

Before tracing the operation of the events set in action by the removal of the telephone from the hook, let us follow the lines from the instrument to the switchboard in the latest type of the telephone system.

[1] Abstract of a paper read before the Brooklyn Institute of Arts and Sciences, Polytechnic Institute, Brooklyn, Friday, April 28, 1905.

TELEPHONE LINES.

Following the course of the lines from the subscriber's instrument, the aerial wires are of copper which has been treated by the hard-drawn process, as commercial copper is too ductile and has but little of the elastic property of resilience by returning to its original length when stretched by a load of snow or by a low temperature.

Hard-drawn copper might be classed as one of the modern inventions which the ancients stole if the accounts of early implements may be accepted, but investigations showing that bronze had been supposed to be copper have absolved these people of anticipating the work of Mr. Thomas B. Doolittle, who produced hard-drawn copper by omitting the annealing during the latter part of the process, and obtained copper wire which retains the electrical conductivity of commercial copper, while its tensile strength is doubled, and it is divested of the tendency to continually stretch under its own weight.

The substitution of hard-drawn copper wire for iron wire formerly in use has increased the limit of telephone conversation under other equal conditions about four times, and by its better conductivity has diminished the waste of electricity used in telegraphy or electric lighting and transmission of power, or, what has been more important, has extended the limits of its application.

For local use, these wires are generally one-tenth of an inch in diameter, and for long-distance lines, larger wires about one-sixth of an inch diameter are used.

The contact of these wires with those of other electrical circuits used for lighting or for power to which reference has been made is not the only difficulty, for the mere proximity of other wires conducting these powerful currents will, if they are of changing polarity, produce sympathetic currents by induction in the telephone wires, and acting on the telephone are the occasion of various noises which at times interfere with the transmission of speech through the telephone, furnishing examples of wireless telephony which are impediments to the usual service.

This interference by induction is minimized by transposing the telephone wires to various positions on the cross-arms, so that the result will be neutralized by imposing such conditions of position that

these disturbing elements will counteract each other.

The wires of underground cables are laid in twisted pairs so that they are immune to inductive influences.

An aerial line is subject to the attack of all manner of disintegrating conditions; poles decay and break, branches fall from trees and wreck the wires.

It is as unfeasible to make a pole line equal to stress of weather beyond peradventure as it is to make the rigging of a vessel equal to the impact of all storms, for when a sleet-storm builds the wires to icy lines, three inches in diameter, sail is set for the gale to sway the lines until the poles are broken.

During a recent winter, the destruction of aerial telephone, telegraph, and electric light lines in the New England states was estimated to be greater than the loss by shipwreck on the New England coast.

This breaking of lines has been prevented on local wires whenever it has been feasible to substitute aerial cables, each containing a number of wires, in place of the open wiring, but for long-distance and toll wires it has been necessary for electrical reasons to retain open wires.

The gales on the summit of the Rocky mountain passes are so severe that neither poles nor lines will withstand the stress of winter weather, although lines have been built with poles set only fifteen feet apart, yet the sleet builds them up to large dimensions which yield upon the impact of winter gales.

Communication, however, is permanently carried on along these routes by means of submarine armored cables which have been buried in trenches excavated among the rocks.

In addition to the facilities for concentrating forces for immediate repair in case of wreck, the lines are inspected by a patrol to give forewarning of imminent breakage.

These men brave the wilderness and face the elements through sun and through storm, the miasma of southern swamps to the rocky fastnesses of western ranges, in the rigors of heat and of cold, all in order to give every assurance of human power that the response will be made when the telephone is taken from the hook.

Difficulties with aerial wires are by no means confined to those occurring under the severe conditions of northern winters, for each country appears to have troubles of its own.

When telephone lines were first built in Mexico, it was naturally assumed that the absence of severe weather conditions would warrant the use of lighter wires and small porcelain insulators, but these lines proved of great interest to parrots and ring-tail monkeys which made nightly visits to the lines in such great numbers for gymnastic practice as to break the wires; and it became necessary to use as strong construction as in northern climates.

In forest districts, wooden poles are occasionally gnawed down by bears which hear the humming of the wires and vainly seek to break in to some hive of bees.

UNDERGROUND WIRES.

The aerial lines pass from the poles into underground conduits in the congested part of cities, flying from the mishaps of storms and crosses to other difficulties which are largely those of greater expenditure and electrical problems.

The underground system is older than the aerial system of electric conductors in applied electricity, for a portion of Morse's invention of the telegraph consisted in methods of burying the wires, but the first seven miles from Baltimore laid underground in lead pipes placed in a plow furrow proved inoperative.

The underground conduits usually consist of groups of continuous ducts, generally three inches in diameter, and made either of vitrified tile, cement monoliths reenforced with iron, or creosoted timber.

Every few hundred feet these conduits lead to an underground chamber for the purpose of obtaining access to the cable to provide for branches to the service of patrons, and also joining the ends of sections of the cables together.

These underground cables consist of from two to six hundred twisted pairs of wires insulated with paper and the whole covered with a lead sheath.

The electrical difficulties of telephoning through underground conductors were at first prohibitive in their nature, but improvements enabled this to be done later, but in the face of conditions which rendered one mile of underground the equivalent of fifty-two miles of overhead wire; but in the modern cable one mile of underground is the equivalent of twenty-eight miles of overhead copper wire one-sixth of an inch diameter, or twelve and a half miles of overhead copper wire one-tenth of an inch diameter.

These conditions are so severe that on long lines it is necessary to pass around intermediate cities to avoid underground wires, and in the suburbs of large cities are switching stations by which connections may be provided to enable patrons to send their messages by branch lines direct into the cities, or permitted to continue on the main line to places beyond.

Conditions of safety and good service require that a telephone underground system should not also include lines of electric lighting and power circuits, and serious mishaps have occurred in the few instances where the attempt has been made to place these diverse types of electric circuits adjacent to each other in the same underground system.

The rapid corrosion of the lead sheaths or underground cables, even in localities where lead pipes had laid uninjured for many years, was an unexpected occurrence of the most serious nature; and it remained for the late I. H. Farnham, of the New England Telephone and Telegraph Company, to discover in August, 1891, that this impairment was caused by the return currents of the grounded circuits of the trolley railroad systems, whose passage through the earth, from the cars where they left the motors to the ground plates under the generators at the central power stations, produced chemical effects similar in principle to those of electroplating, by which metal was removed from the underground telephone cables, gas and water mains, and deposited beneath the rails.

At the instance of Mr. F. S. Pearson, chief engineer of the West End Street Railway, in November, 1892, the currents used in trolley railroad practice were reversed in polarity from the customary method prevailing at the time, so that the trolley wire would be positive to the earth, and the return currents would tend to build up material on all continuous metallic underground construction until near to the central electric power station, where the electricity leaves such conductors for the ground plates under the generators operating the trolley system, and would therefore produce more active impairment by the removal at this point, were it not for large copper rods connecting these underground pipes and cables to the ground plates.

This course reduced the difficulty in the measure that it was capable of being carried out in practice, for electricity follows divided lines in proportion to their relative conductivity, and a certain amount will follow along the underground conductors until it reaches a direct path of electrical conductivity leading to the ground plates.

This treatment of the problem appears to have been more satisfactory with continuous underground conductors, such as electric cables, than it is with underground

pipes having joints of different electrochemical equivalencies.

The divergence of the return currents from the rails has been reduced by bonding the rails together with copper rods, or by casting iron around the ends of the rails, and also the use of heavier rails.

OFFICE DISTRIBUTION OF WIRES.

The terminals of the underground cable at the telephone central station emerge from their lead sheaths and are spread out upon a large iron rack known as a distributing frame, where the insulated wires are equipped with protectors for the same purpose as those at the subscriber's instrument, and the wires are changed from the order in which they are received from the cable to another classification, and thence to a similar rack called the intermediate frame where the wires are grouped to the individual operators, which latter arrangement may be changed from time to time, as the number of telephones to which an operator can give attention varies according to the character of the service.

THE SWITCHBOARD.

The function of the switchboard is merely to place the ends of the wires from one telephone in electrical contact with those of any other telephone in the exchange, with suitable signals for calling the operator and the party addressed, and this system has been amplified until one human voice can reach to districts including considerably more than half of the population of the United States, and the interlacing has been so complete that its service reaches the smaller villages.

In the new switchboards the dropping shutter has been supplanted by a flash of a lamp to signal the operator; the turning of a crank to generate a current for moving a shutter is no longer necessary, and the subscriber removes the telephone from the hook and is ready to begin; galvanic batteries are not installed at the subscriber's equipment, but the whole of the electric energy is supplied by storage batteries at the telephone central station.

When a call for a telephone connected to some other switchboard is received, as the operator can not reach a line directly to the desired telephone, the call is transmitted by an office line to a special operator at another switchboard, where it is noted on a memorandum blank, and the time automatically recorded by means of a clock-registering stamp; then the call is transmitted by trunk lines to the desired telephone central station, or it may be to some station which can reach the desired subscriber, and in some instances it is necessary to transmit the message through a greater number of telephone offices, each one building up the line by additions, and every operator also keeping, by means of the time stamp on memorandum blanks, a record of the hour and minute of each step from the initial call to the final termination of the conversation and the release of the lines.

As soon as an operator has finished the entries on a memorandum blank it is placed in a small orifice, where it is carried by air pressure, through tubes in the manner similar to the well-known cash carriers, to another department where it is compared with similar memoranda made on the same conversation at other points on the line by clerks, and these form the authority for the charge for the toll service.

These memorandum blanks are compared by clerks, and must balance as in other bookkeeping, and form the authority for the charge for the service.

In some instances, where there is a great load of service on long-distance lines, the communication from one central station to another by the operators for the purpose of obtaining the desired party at the telephone is carried on by telegraphing over the telephone lines; for there are methods by which this can be done without interfering with the transmission of conversation at the same time on the identical wires, and these lines branch near to their terminals where each class of electrical currents is transmitted to its proper instrument, whether of the telegraph or the telephone system.

A telephone switchboard is an exception to general forms of construction in that the cost per unit increases at a greater rate than the enlargement, and this is due to the fact that, as the operator who receives a call from a subscriber must be able to reach the terminals leading from the switchboard to any other telephone or to the switchboards at other stations, and therefore, each set of telephone wires must have as many sockets and branches as there are operators' sections at the switchboard.

For example, in a small switchboard with two operators' sections, there would be two sets of such branches and sockets for each telephone line, while in a large switchboard with fifty operators' sections, there would be fifty sets of such connections for each telephone line instead of the two sets mentioned in the first instance, the number of this class of connections multiplying twenty-five times for each telephone, in order to enable each operator to reach all subscribers connected to that switchboard.

This difference in cost may be appreciated by reference to the material entering into the composition of a switchboard for 10,000 telephones and one for 600 telephones, the individual items in each being alike and of the same cost.

In the larger switchboard there are 2,500,000 soldered connections, or 250 to each telephone; and in the smaller switchboard there are 43,000 soldered connections, or about seventy-two to each telephone.

In the larger switchboard there are 10,000 miles of wire, or one mile to each telephone; while in the smaller switchboard, there are 220 miles of wire, or about one-third of a mile to each telephone.

There is an exaggerated opinion of the damageability of a switchboard by water, and while it is perfectly true that it must be thoroughly dry for practical operation, yet switchboards have been thoroughly wet and restored to good service by drying out. It is the general custom to provide waterproof covers for switchboards as well as for generators and motors whenever it is considered that there is any hazard of a water damage from fires in other parts of the building which might cause an interruption in the service.

The charge for maintenance is far greater than that of the operation of the telephone system, being the greatest single expense. One-third of the gross revenue of a telephone company is necessary to preserve the plant in good order without any reference to the cost of extensions or of operation.

THE VARIABLE USE OF TELEPHONES.

The grouping of the use of the telephone may well serve as the basis of a sociological study of the habits and customs of a community, but for studying the conditions of service for which provision must be made, the number of communications each hour of the whole day is taken from time to time, and the result plotted in a diagram whose hills and valleys indicate the relative load of service on the system.

Whatever disturbs travel also affects telephony, as may be noted by the increase in the number of calls, even to full capacity, during storms or in extremely hot weather.

In all cases, the night use between 7 P. M. and 7 A. M. is a small proportion of day use, and while these calls are largely of the important nature of emergency calls for fire department, physician, or police, yet in number they are slightly

over one per cent of the calls of the whole twenty-four hours; but the calls during the day begin to increase suddenly at some hour in the forenoon after the morning mail has received attention, and approach the congestion limit in the middle of the day, falling off suddenly as offices are being closed, and resuming activity in the larger cities late in the afternoon when arrangements for dinner or theatre are being made.

THE EXTENT OF ITS INTRODUCTION.

The total amount of telephone line of the Bell system throughout the United States averages three and twenty-nine hundredths miles for each telephone instrument, and, excluding the long-distance lines, fifty-five per cent of the wire is underground.

When a person calls up another telephone, the average line plant at his disposal is six and fifty-eight hundredths miles; truly "it is cheaper to talk than to travel."

The long-distance wires interlace the whole system into a unity from the Atlantic to the western side of the Mississippi valley where the short gap of 140 miles which now exists will be closed in the immediate future to connect with the similar system of lines binding together the various cities of the Pacific slope.

This growth of the lines of the system is the result of a purpose to extend the use of the telephone to every town, no matter how small, throughout the United States; and in all of the cities and towns to put a telephone, at the most reasonable rates, "within easy and immediate reach of every person whose income is sufficient to permit him to ride on street cars."

The extent to which this policy has been put into actual construction is indicated by the fact that, while the last census gives a record of 10,602 incorporated cities, towns, villages, and boroughs in the United States, there is telephone communication to 26,128 different settlements, and the continued growth of extensions postpones, year by year, the saturation point of telephone service which has been recurrently anticipated by conservative persons.

THE OPERATION.

The telephone business in its complications on one hand, and its close relations with the needs of its patrons on the other, is one requiring active zeal.

Under American conditions the equipment of the plant and its attendance must be adequate to give practically instantaneous service at all times, even though the demands at night are but slight in comparison to the requirements of the day.

Reference is frequently made to the low cost of telephone service in European countries, but it should be remembered that it is furnished under lower wages and material conditions far different from those of this country.

The government owns the buildings, and the department does not pay taxes, rent, or maintenance; the army engineer corps builds the subway as a government charge; and the pole lines are built by another department without any charge to the telephone system for material or right of eminent domain.

The demands of American patronage require that the plant and attendance should be adequate to provide prompt responsive service; but in these countries there are so few toll lines that requests for long-distance service are received in the order of their application, and the patron must wait—be it minutes or hours—until a line is at liberty.

The striking feature of the two great applications of electricity which are used by the public, namely, the street car and the telephone system, is that, however complex their mechanism, their use is extremely simple.

It has been a matter of slow growth for the subscribers at large to use the telephone in the best and simplest manner, and that is to speak clearly rather than loud, and to avoid the use of merely formal words in calling for the number wanted.

Nothing reveals more prominently the innate courtesy of a person than the manner of address over the telephone, whether to operator or subscriber.

Operators are prepared by a short course in a special training school which differs from other institutions of learning, except West Point and Annapolis, in that they are under pay during the period of tuition.

The result of such systematic work in connection with improved apparatus in New York, which is cited as an example, because the exact statistics are at hand, has reduced the time of making complete local connections during the last five years three and nine-tenths seconds, which may appear a short time to any one, except when waiting at a telephone, but this small amount of time, when applied to all the telephone connections of the Bell system in the United States, amounts to 10,098 hours a day saved to the subscribers' time, or about three and nine-tenths years in eight-hour days. The saving of time in disconnections, largely owing to the common battery switchboard signaling the operator by lights rather than shutters, enables the lines to be released when a conversation is at an end, three and two-third times as rapidly as formerly, and this is of great advantage to the subscriber in making repeated calls.

These improvements in calling save 1,400 years of subscribers' time every year, and over three times as much time in disconnecting, a part of which time is available for the benefit of the subscriber, but no one has ever ventured to estimate the gross amount of time saved by the use of the telephone.

The vast system provides for over 10,000,000 calls per day, or nearly 2,500 calls a year originating at each telephone, and this means that an equal number of calls are received on the average telephone, so that each telephone averages being in use 5,000 times a year.

The interruption to service has been reduced to a very slight matter, and this is generally owing to an enlargement of the plant, where the changes are made at night. In New York the interruption to each substation from all causes is one hour and twenty-one minutes a year, generally without the subscriber's knowledge, as is shown by the fact that the complaints are only one to 15,138 lines per day, or once in forty-one years per telephone.

LONG-DISTANCE TELEPHONY.

The toll line service began with the line built from Boston to Lowell in 1879, and this revealed both the functional possibilities of the telephone and the great many technical difficulties which have been overcome. In the space of twenty-five years the length of long-distance telephone lines has increased from 27 to 275,000 miles. But these lines are not to be considered as comprising all of the lines outside of any municipality, as they can be attached to lines about 4,000,000 miles in length and radiating at these points, reach to the desired subscriber.

The long-distance commercial service may be considered to date from the New York and Chicago line which was opened on October 18, 1892, by Dr. Alexander Graham Bell in the presence of a concourse of persons eminent in electrical affairs, and on February 7, 1893, Governor William E. Russell and a body of prominent Boston men opened the line from Boston to Chicago.

In short, its applications are becoming more extended as the emergency of yesterday becomes the precedent of to-day.

TELEPHONE RATES.

The fundamental unit of the cost of telephone service is based upon the use of

the instrument or the number of the calls rather than the instrument itself as a basis, and the results of improvements in apparatus and methods of administration are continually diminishing the cost of telephone rentals.

The increase during the year 1904 amounted to 701,047 telephones and 712,147 miles of line wire, which, with its attendant construction, cost $33,436,700, being an increment of twenty per cent, which brought the whole number to 4,480,564 telephones, requiring 4,671,038 miles of line wire to reach their patrons.

This work is requiring extensive investment of capital to make these extensions and to build the plant in such a permanent manner as to give assurance of the continuity of this valuable service, and it is of the most favorable significance that this aspect of the system is being so thoroughly accepted by the patrons, who appreciate that its affairs must be conducted on a basis which will assure good and permanent service, and that it is essential that the service must be paid for at a price which will continue its quality and maintain the plant, giving a reasonable profit which will not only conserve present enterprises, but also attract additional capital as it may be needed for future growth of the business.

BOOK REVIEWS.

"The Pocketbook of Refrigeration and Ice-Making." Fourth edition. A. J. Wallis-Tayler. New York. The Norman W. Henley Publishing Company. Cloth. 184 pages. 5 by 7 inches. 31 diagrams. Supplied by the ELECTRICAL REVIEW at $1.50.

This book has been published with a view of meeting the demand for a handy pocketbook which should contain, in an accessible form, such formulæ, data, tables and memoranda as are constantly required by persons engaged or interested in the industries connected with refrigeration and cold storage. The book covers the subjects of refrigeration, cold storage, ice-making and the storage of ice, insulation, the testing and management of refrigerating machinery, general tables and memoranda, and other topics of allied interest.

"The Berlin-Zossen Electric Railway Tests of 1903." Translated from the German by Franz Welz, with an introduction discussing the general subject of train resistance by Dr. Louis Bell. New York. McGraw Publishing Company. Cloth. 100 pages. 8 by 11½ inches. 18 illustrations, and 38 full-page diagrams, curves and plates. Supplied by the ELECTRICAL REVIEW at $3.

With the general results of the noteworthy Berlin-Zossen high-speed railway tests most engineers are familiar. It is, however, convenient to have the complete report of these tests published in book form. In addition to the valuable information contained in this report, the introduction by Dr. Louis Bell, on the general subject of train resistance, is an interesting discussion of the addition to our knowledge of train resistance made by these tests. In an appendix is an abstract from the reports of the Allgemeine Elektricitäts Gesellschaft and the Siemens & Halske Aktiengesellschaft, concerning the proposed high-speed electric railway between Berlin and Hamburg.

"The Telegraphist's Guide to the Departmental and City and Guilds Examinations in Telegraphy." Fifth edition. James Bell and S. Wilson. London. S. Rentell & Company, Limited. Flexible cloth. 227 pages. 5 by 7¼ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at 75 cents.

This book is a compilation of a series of articles written for an English technical paper, for the purpose of instructing those intending to take the examination for telegraphist for the government service. The writer, however, has not confined himself to the bare requirements of that examination, and the guide has been made suitable for preparing candidates for the examinations in telegraphy conducted by the city and guilds of London Institute. The work describes, in a detailed way, the various appliances used in telegraphic work, with diagrams illustrating the method of installation and operation. The apparatus used for testing, and the method of employing it, are also described. The book covers very satisfactorily English systems of telegraphy.

"American Telephone Practice." Fourth edition, enlarged and entirely rewritten. Kempster B. Miller. New York. McGraw Publishing Company. Cloth. 904 pages. 7 by 10 inches. 643 illustrations. Supplied by the ELECTRICAL REVIEW at $4.

The fourth edition of this standard work on telephony is practically a new work, for the book has been largely rewritten and greatly expanded. The work covers the telephone practice of to-day much more comprehensively and accurately than was true of the earlier editions at the time of their publication. In order that the work should not become too bulky, a good deal of matter of purely historical interest has been eliminated. The book is divided into forty-two chapters, each dealing with some particular branch of telephone practice—an arrangement which adds much to the value of the work as a book of reference. Every phase of telephone construction and operation is dealt with, the various systems are described, including the manual, automatic and intercommunicating, and construction work, both inside and outside, is described in detail. The book is, without doubt, one of the most complete works ever published on American telephone practice, which, it need hardly be said, is in advance of that of any other country.

"Practical Electric Light Fitting." Sixth edition. F. C. Allsop. New York. The Macmillan Company. Cloth. 290 pages. 5½ by 7½ inches. 242 illustrations. Supplied by the ELECTRICAL REVIEW at $1.50.

In preparing this book the endeavor has been made to provide a thoroughly practical treatise for fitters and others who require plain, practical instruction and diagrams, rather than mathematical formulæ. The subject is treated by giving an exceedingly elementary account of electric current flow and the different systems of electrical supply which are in use. The greater part of the work is given up to a detailed description of different types of switches and switch boxes of all descriptions, fuses, lamp fittings, methods of running wire in conduit, the installation of meters, and such testing as is required in interior wiring. While the book is written from the English standpoint, a good deal of American apparatus is described. The book concludes with instructions for installing and operating a small isolated plant.

A Projection System for Lecturers.

An ingenious and simple method of illustrating lectures by means of lantern slides is described by Professor Eric Gerard in the bulletin of the Association des Ingenieurs Electriciens (Paris) for the last quarter of 1904. This system, which has been installed in the new auditorium of the Institut Montefiore, is novel in that no darkening of the auditorium is necessary, and the lantern is not in view. The lantern itself is placed in a rear room, such as is usually provided for storing and preparing apparatus. In an opening of the wall between this room and the lecture room is placed a large sheet of ground glass. To avoid the necessity of darkening the preparation room, the screen is enclosed so as to cut off all side lights. The lamp used is a direct-current arc lamp taking fifteen amperes, and it is placed 2.5 metres from the glass screen. The slides which are to be shown are placed between the lamp and the screen, and the illustrations are shown on the screen in the usual way. To avoid the necessity of having an assistant in the rear room, the slides are mounted on a large wheel, built somewhat like a bicycle wheel, the movements of which are controlled by means of a cord from the lecture room. The whole apparatus is under the control of the lecturer, and its effectiveness is thus greatly increased.

ELECTRICAL MINING NOTES.

BY SYDNEY F. WALKER.

ELECTRIC COAL-CUTTING MACHINES.

There is a very instructive struggle going on at the present time in connection with electric coal cutters. As usual, the electric system of driving is steadily pushing out the other. It is not in the collieries, where coal-cutting machines have been at work for a long time, that changes are taking place; it is in the new installations which are being constantly put down that a largely increasing number are being arranged for electric driving. It is also not in specially difficult places so much that electric driving is making way. The converted air drill that was introduced a few years since for coal-cutting, in which arcs are swept out by the drill, and in that way undercutting or nicking is done, is making way steadily for "bord and pillar work" and in narrow workings. It is in the straight forward longwall work that the electric longwall machine is making way. There are at present three types on the market, the bar, the disc, and the chain or jib. Up till very recently the disc was the machine, because it could be depended upon to go on cutting, no matter what happened. It would cut through anything and would work continuously under pretty near all conditions met with in a coal mine. The bar, it was acknowledged, took less power, but that was not of much service when it was constantly breaking down. Now all that is changed. The bar is doing good work, and it takes less power, from the fact that it avoids obstacles, such as nodules of pyrites, instead of going through them, as the disc does. There are also now two bar machines in the field, both old friends. There is the Hurd, that has been slowly making its way for a good many years, and has now proved itself by actual work a thoroughly practical machine, and the earlier machine, the Goolden, that had been put on one side as impracticable. A mining engineer, a past president of the Mining Institute, who has been working his colliery by electricity for some time, and who appears to have a very good electrician, has taken it up and claims to have produced a better machine with less gearing than the Hurd. The Hurd, it will be remembered, goes around obstacles, gearing carrying the bar up or down out of the way; it also has a reciprocating motion, and the bar is in the form of a screw, a plate placed behind it completing an Archimedean screw which brings the dirt out. In the new Goolden, it is claimed, the gearing is less, there is no reciprocating motion, the bar goes around obstacles as the Hurd does, and it is claimed there is less to get out of order. In the early Hurd machines the gearing was often a great source of trouble. The manager in question is using the machine in his own colliery, and is doing good work with it. The bar of the new Goolden machine is square, the cutters being fixed in the squared faces.

DEVELOPMENT IN DISC MACHINES.

The competition of the bar machine has led the makers of disc machines to bestir themselves. The Clarke-Steavenson Company has recently introduced worm gearing into its machine. As with all electrical drives, the reduction of the speed is always an important factor. Power is frequently lost in the gearing, especially when it has to run in places like the face of the coal, where dirt abounds, and the gear-wheels and their shafts take up room that can be ill-spared. Up till very recently, however, worm gearing was out of the question—it was so inefficient. In the early days of the Goolden machine, a machine was made with worm gearing, and its gear absorbed so much power that there was none left to cut the coal, the motor at that date being very weak also. During recent years, however, with the advance in engineering methods, the methods of cutting the teeth of worm gearing, and of running the gear have been considerably improved. The thrust bearing for worm gears now usually runs on ball bearings. The Clarke-Steavenson Company claims that it saves thirty-five per cent of the power by means of the new gear, that there is less vibration, and absolutely silent running. This last is of enormous importance, as one of the great drawbacks to all coal-cutting machines is the noise they make, preventing the warning sounds of the roof from being heard.

A curious problem has come up in connection with disc machines that use two motors. In one particular case it was found that the motors broke down rather frequently, and the insurance company made some tests, with the result that it found that the pressure at the terminals of the two motors varied very considerably, and was rarely the same. The two motors are series-wound, and are connected in series. The current passing through the pair must of course be the same. Each motor is geared to a second motion shaft by bevel gear, the two second motion shafts driving a third shaft, which drives the disc. The case is made more peculiar by the fact that in the same colliery there is an identically similar machine, working under exactly similar conditions, which never gives any trouble at all. In my opinion the troubles are due to the personal element, which is so strong in these cases. I am strongly reminded of a similar pair of cases I had in the very early days of electricity in mining. I had charge of two signals, working to two engine houses close to the same pit bottom, and working under identically similar conditions. The attendant in one engine house was an oldish man, very careful and very clean. Though it was not easy under the conditions, he was always clean himself, and so was his engine, and so was my battery, and I rarely had any trouble with it. The attendant in the other engine house was a much younger man who was not careful and not clean, and I always had trouble with his battery. It strikes me that this is the case with these two machines. There is no electrician on the ground, so that the apparatus is absolutely dependent upon the attention of the men in charge, and that of the colliery mechanic. The probable cause of the whole trouble is dirt. It is not an easy matter to keep the coal dust out of the gearing and from the commutator in a coal-cutting machine. Coal dust is being made all the time, and is finding its way everywhere. You will find it right down your back when you undress after watching a machine. Further, it is not easy to keep the motor brushes free from coal dust, and from making copper dust, which again deposits everywhere, including the spaces between the end of the coils, and so on. It is not easy, unless you take a little trouble, but it can be done with a little trouble and a little knowledge intelligently applied, and that is what is wanted here. If the copper dust and the coal dust are cleared out every time the machine stops, which does not take long to accomplish, the dust has no chance to accumulate. If this is done with care there should be very little trouble, very little variation in the pressures, and very few burnouts. My view is that the differences in the terminal pressures were not the cause of the burnouts, though they may have aided the process, but the copper and coal dust, these producing the differences of pressure, and building bridges across between sections of the commutator and the ends of coils, the bridges being burned, and arcs following, when there was some change in the circuit, in the usual way.

Electrical Notes from Europe.

By Our Special Correspondent.

THE Lyons tramway lines, which are now using current from a steam-operated central station lying within the city, are soon to take current from a hydraulic station at some distance off. The Société Grenobloise lately received the concession for supplying the tramways with this current. The hydraulic plant, which is located at Montiers, is equipped with Thury machines on the direct-current system. It contains four double dynamos, each pair being mounted together and connected direct with one of the turbines. The receiving station at Lyons is equipped with five double motor groups. It is to be remarked that the transmission between Montiers and Lyons is greater than any yet attempted in Europe, being 180 kilometres (112 miles). The central station is to generate 6,300 horse-power in all, and will use a sixty-five-metre head of water. It was decided to use the Thury constant-current system, as it gives a considerable economy of copper. The plant is on the same lines as the St. Maurice-Lausanne system, which uses a fifty-eight-kilometre (thirty-five-mile) transmission line at 22,000 volts. In these cases the current is constant at all loads, while the voltage is variable. In the new plant the voltage will be 57,000 volts at full load, which is the highest yet employed in Europe. A simple line of two nine-millimetre copper wires will be used. Within the city of Lyons the circuits will be laid underground, with an armored cable of high insulation.

The Austrian government is taking measures toward the application of hydraulic power for railroad lines. In a recent report, the Council of Industry gives a favorable opinion as to the use of hydraulic stations for supplying electric traction on the new railroads of the Alpine region, and it decided to request the government to undertake a thorough and detailed investigation regarding the nature and location of the different falls which may be available for this purpose. It is also proposed to draw up a plan of all the falls in the country, with detailed indications as to each. The railroad companies are favorable to this idea, and by forming a detailed list of the sources of water power, the railroads can select the falls which are most desirable, leaving the others for the industries and agriculture.

A large hydraulic plant is now in construction in Austria on the Sill river near Innsprück. The current is to be used at the latter locality which lies seven miles distant, for lighting and power. From the dam which has been erected across the river the water is brought by a 4.5-mile tunnel which has a one per cent slope. A penstock, 400 metres long, runs from the end of the tunnel down to the station, with a 187-metre fall. It delivers from seven to four cubic metres per second, according to the season, and furnishes from 13,000 to 10,000 horse-power. The station contains six turbine and dynamo sets of 2,500 horse-power each. Current is generated at 10,000 volts and runs on an overhead line to Innsprück. Here a number of transformer stations lower the voltage to 2,000 for the lighting and tramways. Among the other new Austrian plants we may mention the hydraulic station which supplies the large paper works of Ignatius Spiro & Son at Kruman, in Bohemia. The plant is located on the Moldan river and the fall supplies six to eight cubic metres per second, giving some 8,000 horse-power. Ganz three-phase alternators are used here, furnishing 2,500 kilowatts and running at 420 revolutions. The current, which is produced at 15,000 volts, is carried overhead to the first paper factory lying fifteen miles off and then to a second works some three miles further on. The motors in the two factories use some 2,000 horse-power in all. A set of three-phase transformers lowers the voltage to 300 volts for the motors. The remainder of the power is distributed in the district for lighting or motors.

Professor Wedding has succeeded in forming a lamp filament into which zirconium enters as the principal element. He presented some samples of the new lamp at a late meeting of the Cologne Electrotechnical Society. The new filament is obtained by the following process: he first forms the material for the filament by mixing zirconium and magnesium oxides and treating them with a current of hydrogen while at a high heat. The oxides are reduced and the resulting composition has a constant value. After powdering and mixing with cellulose solution, a plastic mass is obtained and the filaments are formed from this. The filaments are treated in a gas of the proper composition which contains no oxygen, and then have a metallic appearance. It is said that the new lamps consume two watts per candle-power. They have been made for thirty-seven volts, three on a 110-volt circuit; or at forty-five volts, for five on a 220-volt circuit. The life is stated to be nearly 1,000 hours. One kilogramme of zirconium furnishes 1,000,000 filaments. The lamp will sell for 1.85 francs ($0.37). Higher candle-power can be obtained by combining several filaments in the same bulb, and it is expected to make 100-candle-power lamps.

Among the new monophase electric tramway lines we may note the new road which runs through the valley of the Stubai, in the Tyrol. The line connects the town of Innsprück with Fulpnels. A voltage of 2,500 is used on the overhead line. This is supplied from the Sill hydraulic plant near Innsprück over a 10,000-volt transmission circuit, with step-down transformers at various points. The trolley wire, which is a thirty-five-millimetre hard-drawn copper wire, is hung from a steel wire which passes along above it. The latter is a five-millimetre wire and is attached to supports at fifty-metre intervals. The copper wire is hung from the steel wire by short supporting pieces placed four metres apart. Porcelain insulators placed on bracket poles are used for the steel wire in the case of single track, and for double track there is a bridge-piece running across the track between two poles. Current is taken into the car by a bow trolley. The wire is some 5.5 metres above the ground. Motor cars, trailers and closed freight cars are used on the line. The motor cars have two bogies of two axles each, and carry four motors of the Winter-Eichberg pattern, furnishing 280 horse-power. The motors are connected two in parallel and have a special controller. A transformer is placed on the car which receives the primary voltage of 2,500 (at forty-two reversals) and has a double secondary which gives 525 and 400 volts for the motors. This line is one of the few in Europe which uses monophase current. It has been equipped by the Allgemeine Electric Company and the Union Company, of Vienna. The track is one-metre gauge and the line is some twelve miles long. The trains run at fifteen or twenty miles an hour.

The German Imperial Laboratory has recently examined some interesting alloys which were submitted by Dr. Heusler,

and which are magnetic in character, although they are composed of non-magnetic metals. Two specimens were tested. The first contains 61.5 per cent copper, 23.5 per cent manganese, 15 per cent aluminum, 0.1 per cent lead. The second has the same metals in the following order, 67.7; 20.5; 10.7 and 1.2 per cent. Rods were turned from the alloys, eighteen centimetres long and .0.6 diameter. The first alloy could be easily worked, but the second proved to be somewhat brittle. The rods were submitted to a magnetizing force and induction test, and furnished a curve of which the following are the principal figures. Values of H in centimetre-gramme-second units: 30, 60, 100, 120, 150. Corresponding values of B for the first sample: 3,750, 4,000, 4,100, 4,200, 4,500. For the second sample: 1,530, 1,600, 1,750, 1,765, 1,820. As will be observed, the alloys are somewhat magnetic. Experiments were made to show the effect of temperature variations on the samples. No change is seen when they are cooled in liquid air for ten hours. The second sample has its magnetic properties considerably modified when heated for nine hours at a temperature seventy-nine degrees centigrade and then for twenty-seven hours at 110 degrees. In this case we obtain the following figures for B corresponding to the above values of H: 2,440, 2,600, 2,645, 2,760, 2,820. Continuing the heat for 544 hours (after which no change is seen) we have B = 2,760, 2,880, 3,000, 3,040, 3,060. As will be observed, the new alloys possess some remarkable properties.

The project submitted by M. Kraus, a prominent engineer, for the new Metropolitan Subway of Berlin, has been finally adopted by the authorities. According to the present plans, the subway starts from the Kreusberg and passes under the principal avenues. The total length is 18.6 kilometres (11.5 miles) and it is to cost over $12,000,000. The line will use the third or side-rail system and the cars are to resemble the American construction, using a central passage. A speed of twenty-five miles an hour is contemplated. The cars will be divided into first and second class. Special attention is to be paid to ventilating the tunnel and it will have numerous exits so as to avoid accidents. The underground stations and the cars will be well lighted.

Statistics have been recently published in Germany which show the operation of the electric plants in the country during the year 1904. The total number of central stations is 1,100, against 971 in 1903. Close data have been secured as regards 1,028 of these plants. The number of stations producing more than 2,000 kilowatts is fifty-one, and these lie in thirty-three different cities. They give a total of 290,693 kilowatts. The 1,028 electric plants above mentioned operate 5,700,000 incandescent lamps of fifty watts and 111,000 arcs, together with electric motors figuring for 263,000 horse-power. It is stated that the use of current for motors is increasing rapidly, while the lighting has decreased somewhat. The 1,028 stations furnish 530,947 kilowatts, of which the dynamos represent 434,882 kilowatts and the remainder is given by accumulators. As to the kind of current, 843 plants generate direct current, forty-one single-phase or two-phase current, and sixty-three three-phase. There are fifteen plants producing both direct and alternating current (single or two-phase) and sixty-one which furnish both direct and three-phase current. The motive power in the case of 570 central stations is given by steam engines representing 341,248 kilowatts, 109 hydraulic turbines figuring for 14,547 kilowatts, and ninety-four gas engines furnishing 10,050 kilowatts. The total number of electric meters is given at 247,366.

An electrolytic process is now in use for making tin paste. This composition is used in the decorative arts and also for coating paper. Hydrochloric acid in dilute solution is used for the bath. Both the anode and cathode are formed of tin plates. The tin is dissolved off the anode plate under the action of the current, while it is deposited from the solution upon the cathode. A spongy deposit containing hydrogen is thus formed, and when detached from the plate the gas makes it float on the surface, so that it is easily collected without interfering with the action of the cell. It is found that in order to have the proper kind of deposit, hydrogen must be formed along with the tin, otherwise the tin is deposited in a hard and crystalline state. The new electrolytic process is an improvement over the old chemical method, which gives off heavy fumes.

Some experiments have lately been made by the Menier Company, at Noisel, France, upon the use of waste vegetable products for fuel in connection with a gas generator and a motor using a low-carbon gas. These trials have been successful, on the whole, and show that these products can be used to generate gas and run motors for agricultural purposes. Straw, waste hay, leaves of different plants or trees, reeds and like material can be used, and thus give an economical production of gas. The cost per horse-power-hour is much less than for coal, as the latter is high priced. Petrol motors are also expensive to run in this country, so that the new process has a considerable advantage. The best method proposed is to form a group and establish a station furnishing some fifty or seventy-five horse-power with motors supplied by a vertical gas generator, and the station would thus furnish electric power throughout the neighborhood. The different products are collected, dried and pressed into bales weighing some 1,500 pounds per cubic yard. The straw is chopped before baling. The present experiments were tried on a seventy-horse-power plant, using a vertical column gas generator of the Riché pattern and a duplex low-carbon gas motor.

The city of Bilbao will soon be well supplied with current from three large hydraulic stations lying at considerable distances, the Quintana, Puentellarria and the Leizaran plants. The first of these stations is now working. It is operated by the Iberian Hydraulic Company and lies at forty-five miles from the city. This station is electrically equipped by the Schuckert Company. It contains 750 horse-power tubine and alternator groups. The alternators furnish three-phase current at 375 volts, running at 375 revolutions. The total power of the Quintana plant is 3,000 kilowatts. The second station, that of Puentellarria, is now building. It lies forty-two miles from Bilbao and generates 4,500 horse-power. Current will be sent on an overhead line at 30,000 volts. Farther off, sixty-five miles distant, a third plant is to be erected at Leizaran. It will also furnish 30,000 volts and is expected to supply 3,000 kilowatts. Substations in Bilbao to the extent of 12,000 kilowatts will lower the current to 3,000 volts and also supply the low-tension mains.

It is stated that some of the large gold mines in West Africa in the neighborhood of Chitri, on the Tano river (Gold Coast), are to use electric power obtained from a number of hydraulic plants. The power is to be used especially in the gold workings of Prestea, Tarkwa and Ashantee which lie on the east of the Tano river. This stream is the largest in the region after the Volta. Near Chitri it has a difference of level of twenty-three metres on 1,500 metres distance. The highest fall is twelve metres and at this point a hydraulic plant is to be erected which will furnish 20,000 to 45,000 horse-power, and this will be sufficient for the mines of the Gold Coast. The first lines, according to the present project, are to run to Prestea and Tarkwa which lie at sixty and ninety kilometres from Chitri, respectively. The current will be used for operating the gold mines and also for an electric railroad which is to run between these two localities. It is expected to realize an economy of forty or fifty per cent over coal.

C. L. DURAND.

Paris, April 29.

MUNICIPAL LIGHT AND POWER IN TACOMA, WASH.[1]

BY HOWARD JOSLYN.

Prior to municipal ownership, the town of Tacoma purchased its water and electric light from a private corporation, the Tacoma Light and Water Company, which was controlled and mostly owned by persons directly interested in a large amount of real estate in and about the original town site.

On April 11, 1893, the citizens of Tacoma voted for the issuance of twenty-year five per cent bonds to the amount of $2,080,000 for purchase of the light and water plants of the Tacoma Light and Water Company. Of this bond issue, $1,750,000 was for purchase of the light and water plants (with realty) and the remaining $330,000 was for extensions of the water plant.

From general reports of the negotiations prior to the sale and from substantial private authority, it is fair to conclude that $1,500,000 was considered the value of the water plant and its realty, leaving $250,000 as amount paid for the light and power plant.

Prior to the purchase, a committee of the city council made a schedule of the property comprised in both light and water plants; and the machinery, pole lines, etc., composing the electric plant with the valuations are given herewith:

STEAM PLANT.

		Horse-Power.	
1	Westinghouse compound engine.....	160	
1	" " "	140	
1	" simple "	100	
4	Russell simple auto. engines, each...	100	
2	" " " " " ...	65	
12	Horizontal tubular boilers, " ...	60	
3	" " " " ...	125	
		Valued	$53,520

ARC LIGHT PLANT.

		Lights.	
14	Thomson-Houston dynamos, each...	50	
3	American dynamos, each	50	
859	Arc lamps.....	...	
		Valued	$85,100

INCANDESCENT LIGHTING PLANT.

1	Thomson-Houston alternator capacity 120 kilowatts (2,000 lights) with exciter.	
1	Westinghouse 1,500-light alternator with exciter.	
1	Westinghouse 750-light alternator with exciter.	
100	Kilowatts capacity in transformers, 1,000 to 50 volts, and wire serving business district only.	
	Valued	$17,850

STREET LIGHTING SYSTEM.

1,800	poles, each 40 feet, with cross-arms.
7,000	pins and insulators.
130	miles No. 6 insulated copper wire.
400	hoods and irons for street arc lamps.
	Valued $35,270

1 Direct-current 50-hp. power generator.
Buildings and realty.
Valued $5,050

Total, $196,790
Deduct for 10 per cent depreciation, 19,679
Net, $177,111

The plant was housed in a building of wood and corrugated iron which, when built in 1889, contained only the three American and five of the Thomson-Houston arc dynamos with necessary engines and boilers. The alternating-current machinery for incandescent lighting and nine of the arc machines were not installed until 1891, so that the plant can not be taken as having run more than sufficient to put it into good working condition. At time of the sale, the commercial service of the plant, consisting of some 250 arc and 1,500 incandescent lights, was almost entirely confined to the business section; and the hope of extending the lighting service throughout the residence districts had been a strong argument with the people for purchasing the plant.

Some two years previous to this sale, the city had granted another franchise to the Commercial Light and Power Company which had installed and was operating an electric plant with capacity of 100 arc and 5,000 incandescent lights. This plant was apparently in competition with the Tacoma Light and Water Company; but unknown to the public, Mr. C. B. Wright, principal owner of the old company, had, previous to its sale, acquired control of the Commercial Light and Power Company, his supposed competitor. After the city began operating its plant, the Commercial company continued for some years as an active competitor and much surreptitious cutting in lighting rates was carried on. As soon as possible after the purchase the city began buying wire and transformers to extend its service to residence districts, establishing rates therefor of nominally fifty cents per month per sixteen-candle-power lamp, but with rebates and reactions which really made the rate average about twenty-five cents per lamp.

Naturally, with cheap rates, the demand for residence lights became quite vigorous and in 1894 the city purchased another 2,000-light, 1,100-volt alternator to care for this business. The operation of the plant was continued much the same and with reasonable economy and management except in matter of service wires to customers, little attention being paid to the engineering features of the distribution system. The city officials could not see the reason for expending the large amount necessary for copper mains to save losses in transmission and give good service. This resulted in a poor quality of light; at first to residences only and later to the whole city. In the early evening with a large load only the lights near the plant would burn close to full candle-power, and later when the heavy load went off, the voltage not being properly regulated, lights would burn with a brilliancy very gratifying to the eye but expensive in the matter of lamps. In 1896, the city instituted suit against the Tacoma Light and Water Company and Mr. C. B. Wright, to recover a large sum claimed to have been paid by the city in excess of the value of the light and water plants. This litigation resulted in judgment for $750,000 in favor of the city, which claim was settled in 1898 by the city council receiving therefor the sum of $100,000 and the electric light plant of the Commercial Light and Power Company; thereby removing all competition to the city plant except from the Tacoma Gas Company.

In September, 1897, the city entered into a five-year contract with the Tacoma Railway and Power Company, which operated a large steam station by which it should drive the city's dynamos at its steam station, receiving payment for the electric current produced at the following rates according to meter measurements on the city switchboard:

Alternating current for incandescent service at night per kilowatt-hour.....	$0.01625
Alternating current for incandescent service in daytime per kilowatt-hour	.015
Arc light current from city dynamos per kilowatt hour.....	.0175
Direct current 550-volt power current per kilowatt-hour.....	.015

This contract effected a considerable saving to the city in cost of production, which at its own station, as nearly as could be ascertained at the time, had not run less than $0.0225 per kilowatt-hour.

The new arrangement gave the city the advantage of increased motive power and in 1898 it added to its equipment another 2,000-light alternating-current dynamo. Larger and more economical transformers were installed in place of many old ones in the business district, the secondary voltage was changed from 50 to 110 volts, and more copper was added to the distribution mains, thereby reducing the losses in transmission and materially improving the quality of light furnished. After a long period of effort on the part of a few practical men, the city council perceived the great saving to be effected by changing the primary voltage to 2,200 instead of the 1,100 volts previously used; and in 1900 to accomplish this change and meet the further demand the city purchased and installed in the railway station a modern type 1,000-kilowatt, 2,200-volt, revolving field generator, which with additional transformers made the expense

[1] Abstract of a paper read before the Pacific Northwest Society of Engineers, Seattle, Wash., April 1, 1905.

of new construction reach the large figure of $51,000 in this year.

About this time the Snoqualmie Falls Power Company entered the city with its power and was naturally desirous of competing for the city contract. In 1901 the city therefore advertised for electric power to be furnished it after expiration of its contract in 1902, and received the following bids:

SNOQUALMIE FALLS POWER COMPANY.

For alternating current, per kilowatt-hour..	$0.0084
For direct current, " " ..	.0094

TACOMA RAILWAYS COMPANY.

For alternating current, per kilowatt-hour..	$0.00885
For direct current, " " ..	.0097

A contract was entered into with the Snoqualmie Falls Power Company for five years and it began furnishing the city power in October, 1902, which service is still in force.

To secure a lower cost of power for its street arc lamps, the city, in 1902, changed this service from the old-style lamps and arc dynamos to series alternating-current lamps operated from "tub" transformers; and the commercial arcs were replaced with alternating-current lamps operated in multiple on general circuits. All the old arc lamps and arc and incandescent and power generators, together with the engines, boilers and scrap from the old station of the city, were sold. The Tacoma Railways Company purchased the 1,000-kilowatt alternating-current generator at practically its cost to the city; and the year 1903 found the city plant with none of its old station apparatus or any of the machines afterward purchased left on hand. Since the sale of the old plant, all the money expended for extensions and betterments had, with exception of a few machines, gone into wire, transformers, meters for the customers, poles and general materials and labor for the distribution system. The only station equipment owned by the city consisted of a ten-panel distribution switchboard and eight series-arc transformers, each with its switch panel, now located in the substation of the Snoqualmie Falls Power Company.

The general statement of expenditures and revenue for the period of ten and one-half years operation of municipal plant is as follows, according to accounts of the city officials.

EXPENDITURES.

Operation, repairs and maintenance.....	$590,385.45
Extensions and betterments.....	239,438.73
	$829,824.18

REVENUE.

Commercial revenue.....	$591,728.53
City light and power.....	386,330.61
Sundries.....	19,093.28
	$997,152.42
Net earnings, according to city accounts...	$167,328.24

Value of light and power plant, $250,000.

Commercial revenue for 10½ years.....	$591,728.53
Cost city light and power for 10½ years.....	386,330.61
Sale of old equipment.....	19,093.28
	$997,152.42
Operation expenses for 10½ years.....	$590,385.45
Maintenance and depreciation for 10½ years	239,438.73
Interest @ 5% on $250,000 for 10½ years.....	131,250.00
	$961,074.18
Net earnings.....	$36,078.24

Before accepting the above statement, it is advisable to consider two important matters in this connection; first, the fairness of the charges made for city lights and power which compose a considerable part of the revenue of the municipal plant; and second, the loss to the city of the revenue from taxation of this plant had it been the property of private persons or corporation during this period.

CHARGES FOR LIGHT AND POWER TO THE CITY.

For investigation of these charges a reasonable comparison may be had with the rates for street arc lights furnished the city of Seattle by private contract. Prior to the sale the Tacoma Light and Water Company had furnished the city some 404 street arc lights at $144 each per annum. Details of the charge for street and incandescent lights furnished during the first two years after the sale are somewhat uncertain; but the cost of street arc lights constitutes at least ninety per cent of the annual amount charged to city lights, and the following statement of the respective rate per street arc lamp per annum in Tacoma and Seattle for the ten and one-half years will afford a fair comparison of the charges per lamp.

Year.	Tacoma.							Seattle.						
1893	6	months at	$12	per	month,	$72		6	months at	$11.00	per	month,	$66.00	
1894	12	"	"	12	"	"	144	12	"	"	10.25	"	"	123.00
1895	9	"	"	12	"	"	108	12	"	"	10.25	"	"	123.00
1895	3	"	"	11	"	"	33	12	"	"	9.90	"	"	118.80
1896	12	"	"	11	"	"	132	12	"	"	9.00	"	"	108.00
1897	4	"	"	11	"	"	44	12	"	"	8.00	"	"	96.00
1897	8	"	"	8	"	"	64	12	"	"	7.00	"	"	84.00
1898	12	"	"	8	"	"	96	12	"	"	6.00	"	"	72.00
1899	12	"	"	6	"	"	72	12	"	"	6.00	"	"	72.00
1900	12	"	"	6	"	"	72	12	"	"	6.00	"	"	72.00
1901	12	"	"	6	"	"	72	12	"	"	6.00	"	"	72.00
1902	10	"	"	6	"	"	60	12	"	"	5.50	"	"	66.00
1902	2	"	"	5	"	"	10							
1903	12	"	"	5	"	"	60							

Taking into calculation the number of street arc lamps used in Tacoma during the years wherein there is a difference in rates between the two cities, we find that in the earlier years the Tacoma plant charged the city $25,256.80 more than if based on the Seattle rate; while during the later years the rate has at times been less than the Seattle charges to the amount of $8,936.50. Making the deduction we have left $16,320.30 as the net amount of excess charges made in street lighting by the municipal plant.

LOSS OF REVENUE BY TAXATION.

The assessed valuation of the property of the Tacoma Light and Water Company for city taxation in 1892 was $323,950. A conservative estimate of the assessment of the electric plant based upon the purchase price of the two systems would place the assessment against the electric plant, only, at an average of not less than $50,000 during this period.

The total of rates of taxation for city purposes during this period amounted to 109½ mills, thereby placing the amount of taxation revenue lost by the city from this source at $5,475.

SUMMARY.

Deducting the above two amounts from the net earnings hereinbefore given makes the following a conservative statement of the net earnings of the plant during the ten and one-half years.

Net earnings after allowing for interest on bonds.....	$36,078.24
Amount of the overcharge for city lights...	$16,320.30
Amount of taxation revenue lost.....	5,475.00
	$21,795.30
Net earnings to 1904.....	$14,282.94

STATEMENT FOR 1904.

The period of ten and one-half years to the end of 1903 may be aptly termed "the reconstruction period"; and a consideration of the business done by the Tacoma municipal plant in 1904, as shown by the following statement, should give ample knowledge of present conditions.

REVENUE.

Sale of commercial light.....	$115,992.43
Materials sold.....	168.21
Installation of meters.....	1,718.00
Sale of commercial power.....	3,114.70
City light and power.....	26,822.80
	$147,816.14

DISBURSEMENTS.

Expense of operation.....	$57,199.11
Repairs and maintenance.....	9,464.87
Interest and exchange.....	12,520.83
New construction and equipment.....	49,086.59
	$128,271.40
Net earnings.....	$19,544.74

NET EARNINGS.

Examination of the details of the disbursement accounts will show that the

items of expense, including office labor and all operation, repair and new constructions, have been carefully distributed, and that the only item of importance left out the above statement is payment toward a sinking fund for retirement of the $250,000 in bonds falling due in 1913.

To provide a sinking fund for retirement of the bonds in eight and one-half years would require the setting aside annually of at least $25,000 which should earn five per cent per annum until required for payment.

Enquiry into details of the expenditures for new construction and equipment shows that some $35,000 of the above amount was put into copper wire, meters, arc lamps, transformers and poles. The city plant is now well equipped with meters and the distribution system reaches practically every section of importance; from which it may be inferred that it should not be necessary to expend for several years in the future as much as the amount charged to new work in 1904.

Assuming that the commercial revenue of the plant will continue at least as large as last year and the new construction work be cut off for the present, we may add this expenditure to the net earnings giving total earnings over expense of $68,631.33. This amount will pay the sinking fund deposit of $25,000; will take care of the charge to the city for light and power, and leave $16,808.53 for new construction and equipment or additional items of expense in operation.

RATES FOR INCANDESCENT LIGHTING.

During the six years following 1897 the rates were reduced four times by the city council in Tacoma; and, as meters were coming into general use, a comparison of the prices in the following table for monthly consumption up to 100 kilowatt-hours will give the saving to the largest number of people benefited by any lower rate in Tacoma.

FEBRUARY 1, 1897, TO SEPTEMBER 1, 1898.

Consumption.	Rate per Kilowatt-Hour	
	Tacoma.	Seattle.
9.5 kilowatt-hours or less	$0.20	$0.20
10 " " " over	.19	.20
15 " " " "	.18	.20
20 " " " "	.16	.18
25 " " " "	.14	.18
30 " " " "	.12	.17
35 " " " "	.11	.17
40 " " " "	.11	.16
50 " " " "	.11	.15
60 " " " "	.11	.14
80 " " " "	.11	.13
100 " " " "	.11	.12

SEPTEMBER 1, 1898, TO MAY 1, 1899.

6.5 kilowatt-hours or less flat.	$1.25	$1.25
7.75 " " " over	.16	.20
10 " " " "	.15	.20
15.5 " " " "	.14	.20
21 " " " "	.12	.18
27.5 " " " "	.10	.18
30 " " " "	.10	.17
38 " " " "	.08	.17
40 " " " "	.08	.16
50 " " " "	.07	.15
60 " " " "	.07	.14
80 " " " "	.07	.13
100 " " " "	.07	.12

MAY 1, 1899, TO OCTOBER 1, 1900.

6.25 kilowatt-hours or over	$0.12	$0.20
12.5 " " " "	.10	.20
18.75 " " " "	.08	.20
20 " " " "	.08	.18
28.58 " " " "	.07	.18
30 " " " "	.07	.17
40 " " " "	.07	.16
41.76 " " " "	.06	.16
50 " " " "	.06	.15
60 " " " "	.06	.14
80 " " " "	.06	.13
100 " " " "	.06	.12

From October 1 to June 1, 1903, the schedules of rates differed in the basis of charge; the Tacoma prices running the same as last above mentioned and the Seattle rates consisting of a thirty-hour maximum demand of twenty cents per kilowatt-hour and a lower rate for longer usage of lights monthly. The prices in Tacoma, however, would average from twenty to thirty per cent less for a majority of the consumers.

COMPARATIVE PRESENT LIGHTING RATES.

The following is a statement of the rates for lights by meter in Tacoma, which were put into effect June 1, 1903, and are still in force.

For 8 kw.-hours or less per month	$0.50
For 8 to 50 kw.-hours per month, per kw.-hour	.06
For each additional kw.-hour over 50 and up to 100	.05
For each additional kw.-hour over 100 and up to 2,000	.04
For each additional kw.-hour over 2,000	.03

Rate for power may be fixed by commissioner of public works, subject to approval of city council, minimum charge to be $1.50 per month.

POWER FOR THE TACOMA PLANT.

Although the rates for power supplied to the city distribution plant under the contract with the Tacoma Railways Company, in 1897, effected a considerable saving to the city, they were not notably low. On the other hand, the prices for electric current contracted for five years from October, 1902, with the Snoqualmie Falls Power Company are, as a result of the strong competition between the two power companies, very interesting from point of station cost of production.

For the first year of the Snoqualmie power service, up to October, 1903, the consumption by the city plant amounted to 2,878,480 kilowatt-hours, which gives an average consumption during the year of 440 horse-power. Taking into consideration the heavy loads lasting for an hour or more, we find the maximum load to have been 2,220 horse-power, making the load-factor an even twenty per cent.

For the second year, up to October, 1904, the power consumption by the city aggregated 3,660,940 kilowatt-hours, giving an average load of 560 horse-power. The maximum load during this year, not considering short time peaks, was 2,450 horse-power, making the load-factor 22.85 per cent.

In neither of these years was the direct-current power-load, which is paid for at the higher rate of $0.0089 per kilowatt-hour, more than four per cent of the total consumption; and for general consideration the rate may, therefore, be taken at the lower price of $0.0084 per kilowatt-hour.

Taking into calculation this rate and the load-factors given above, the city plant paid for its current during the first mentioned year at the rate of eleven dollars per horse-power per annum; and during the year ending October, 1904, at the rate of $12.55 per horse-power per annum.

It will thus be evident that the city of Tacoma has for at least two years been obtaining its electric power at an exceedingly low rate; and at a cost which it could not hope to duplicate by operating a generating station with steam or gas engines for motive power, nor could such cost be reached with a water-power plant installed at the low first expense of $100 per delivered horse-power.

The Measurements of High Temperatures.

Within the last few years the demand for appliances for pyroelectric measurement has increased markedly, as those industries using high temperatures in connection with the manufacture or preparation of their products have recognized the importance of being able, at any moment, to determine the extent and value of the temperatures attained. As a natural consequence of this increasing use in indicating pyrometers was the introduction of the recording pyrometer, which has a particular use in furnaces which operate night and day, and which can not be under continual supervision. In an article in the *Electrical Magazine*, London, Mr. L. Ramakers describes a recording pyrometer installation for measuring the temperatures prevailing in the hot-air conduits of blast furnaces, and a device which is controlled by means of two thermoelectric couples for recording the temperature of a tempering furnace.

In the former installation each blast furnace has two so-called Cowper apparatus, one of which is traversed by the hot gases coming from the blast furnace, whereby it is heated; while the other has the cold air drawn in from outside driven through it by means of blast engines. In this way cold air is heated to a temperature

of from 700 to 900 degrees centigrade. If the temperature of the latter apparatus—and consequently the air also—has fallen to a predetermined extent, then the cycle of operations is reversed. The first-mentioned freshly heated apparatus is used for heating the air, and the latter is heated afresh. In order to make observation of this process, there is located in the hot-air conduit of each of the blast furnaces—which are arranged in a circle around it—a thermoelement placed in a protecting tube. From the ends of this element wires lead to the common point where the corresponding registering devices are placed. The arrangement is such that every fluctuation in temperature can be seen at a glance, enabling the superintendent to determine any irregularities in the operation of the furnaces. The recording instruments are enclosed in hermetically sealed boxes. They contain a roll of paper sufficient for three or four months' continuous operation.

The recording pyrometer used in the tempering furnaces mentioned above is of particular value because of the exacting requirements now made in connection with the quality of steel for the manufacture of tools. It is essential that individual attention should be given to different kinds of steel, and more especially so during the tempering process. It has been found that the practice of estimating the temperature for tempering by the aid of the eye is by no means sufficient to enable a uniform product to be obtained. The pyrometer, on the other hand, makes it possible to maintain an absolutely constant temperature in a modern gas-fired tempering furnace.

The Ohio Society of Mechanical, Electrical and Steam Engineers.

The tenth meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers will be held Friday and Saturday, May 19 and 20, at Toledo, Ohio. The headquarters of the association will be at the Phythian Castle, Ontario and Jefferson streets. The following programme has been announced:

Friday, May 19, 9 A. M.—Business meeting of council. Business meeting of society. Secretary's report. Treasurer's report. President's report. Report of the committee on the change of by-laws enabling the society to hold meetings outside of the state of Ohio; also to accept as honorary members of the society those connected with the management of plants who are not engineers. A paper will be read by Mr. Robert A. Orin, East Liverpool, Ohio, on "The Abrasive Strength of Materials, with Notes on Actual Tests in Compression."

Friday, May 19, 1 P. M.—The following papers will be presented: "The Colliery Engineer," H. B. Potts, chief engineer, National Coal Company, Byesville, Ohio; "Losses in the Power Plant," Charles N. Harvey, chief engineer, Muskingum Valley Steel Company, Zanesville, Ohio. Later in the afternoon the delegates will visit the gas-engine department of S. M. Jones & Company and the plant of the Pope Motor Car Company.

Friday, May 19, 7.30 P. M.—The following papers will be presented: "Power-Plant Supervision and Accounting," F. W. Ballard, mechanical engineer, Sherwin-Williams Company, Cleveland, Ohio; "Some Recent Improved Forms of Electric Lamps," F. C. Caldwell, professor of electrical engineering, Ohio State University, Columbus, Ohio; "Materials of Boilers—Facts and Theories," J. Rowland Brown, mechanical engineer, Aultman-Taylor Company, Mansfield, Ohio.

Saturday, May 20, 8 A. M.—The following papers will be read: "Pumping Engines and Machinery," Oscar F. Rabbe, mechanical engineer, Heisler Pumping Engine Company, Toledo, Ohio; "Notes on Settings of Horizontal Tubular Boilers," Ezra Fawcett, Alliance, Ohio.

In the afternoon the delegates will visit the plant of the Toledo Furnace Company and the plant of the Ford Plate Glass Company.

The officers of the society are as follows: president, R. H. Probert, Akron, Ohio; vice-presidents, H. H. Kelley, Chicago, Ill.; Henry Jackson, Steubenville, Ohio, and William T. Magruder, Columbus, Ohio; treasurer, O. C. Pillichody, Pittsburg, Pa.; secretary, C. J. Miller, 620 Shorb street, Canton, Ohio.

A Compound Dynamo Brush.

A new type of dynamo brush has been brought out by Messrs. Svenska, of Stockholm, which the inventors believe has some important characteristics. It is known as the bronze-carbon brush, and it is formed by coating the particles of powdered graphite with copper. These coppered particles are then coated with tin, and the tinned particles are pressed together and heated sufficiently to cause the copper and tin coatings to combine to form bronze. Every particle of graphite powder receives a coating of bronze, but as the graphite particles are small, the brush is fairly homogeneous. It takes a polish, is easily soldered, and the twenty per cent of free graphite present acts as a lubricant. These brushes have practically the same conductivity as copper brushes, and, at the same time, they commutate as well as carbon brushes. In fact, they can be used to replace a carbon brush without any other change being required. At a peripheral speed of fifteen metres per second, and a current of ten amperes per square centimetre, the loss of an ordinary carbon brush was found to be 34.5 watts, while with a similar bronze-carbon brush it was only 3.4 watts. The rate of wear of these brushes is slightly greater than that of metal brushes, but the wear on the commutator is correspondingly less.

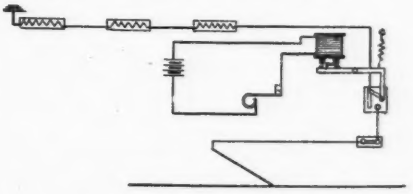
Electrical Patents.

A plug and spring-jack switch is the invention of William W. Dean, of Chicago, Ill., who has assigned his interest in the invention to the Western Electric Company, of Chicago, Ill. (787,900, April 25, 1905). The object of the invention is to provide a plug and spring-jack of improved construction in which certain defects inherent

PLUG AND SPRING-JACK SWITCH.

in devices of the kind heretofore in use will be avoided. The invention has particular reference to the plug and spring-jacks of telephone exchange switchboards. In the embodiment of the invention, front and rear-supporting strips are employed, the rear strip having a pair of contact springs secured thereto and extending forward, one above the other. The upper spring has a hole therein. A contact ring or thimble is located in the front strip, having a tongue extending over the two contact springs back to the rear strip to afford means for attaching the connecting wire. An insulating strip is attached to the underside of the tongue and projects through the hole in the upper contact spring, to form a stop for the lower spring. The stud has a shoulder forming a stop for the upper spring.

Arthur Newton, of Hartford, Ct., has recently invented an electrical system of heating, which is particularly designed for heating electric cars (788,166, April 25, 1905). The object of the invention is to provide a very simple system which can be easily and cheaply installed in cars in use at the present time as well as in new cars, for automatically keeping the temperature of the car near the desired point. In this system, one or more heaters are arranged in a circuit between a source

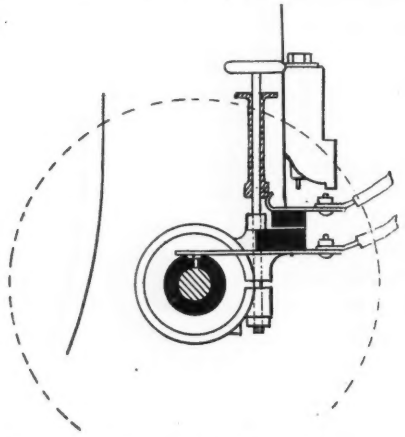


ELECTRICAL SYSTEM OF HEATING.

of electrical energy and the ground, the said circuit including a switch which is adapted to be opened by magnetic means that is energized by another circuit between a source of electrical energy and the ground, which secondary circuit is controlled by a thermostat. A plural number of heaters are disposed about the in-

terior of the vehicle and are connected in an electrical circuit from a traveling contact to a ground or return wire. A manually operative cutout is employed in the circuit, also an automatically operative switch. An electrical circuit from the traveling contact to a ground or return wire is provided and a thermostat is connected in this latter circuit and arranged to open it when the temperature is above a predetermined degree and to close it when the temperature is below a predetermined degree. A magnet is connected in the thermostatic circuit and an armature is adapted to be moved by the magnet. A mechanical connection is arranged between the armature in the thermostatic circuit and the automatic switch in the heater circuit.

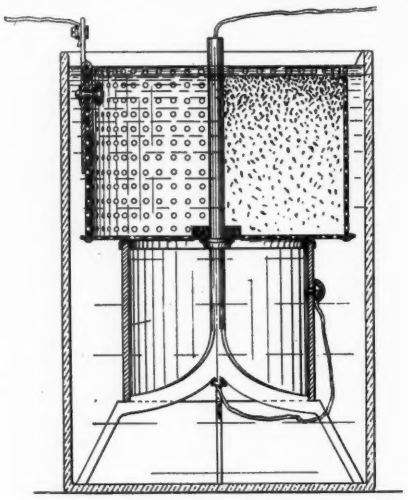
An electric sparking device for explosive engines has been devised and patented by Charles S. Dutton, of Perth Amboy, N. J. (788,253, April 25, 1905). The object of the invention is to provide means for



Sparking Device for Explosive Engines.

igniting the gas at any desired point in the revolution of the engine and for varying the time of ignition at will and to provide means for conveniently interrupting the ignition. In carrying out the invention, an igniting plug is located in the cylinder of an engine. A terminal in the line of an electric circuit is connected with the igniting plug. A shifting or actuating rod is provided on which a metal piece is movable into and out of contact with the terminal.

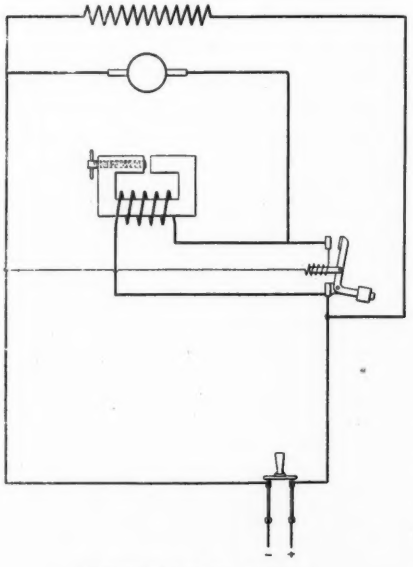
Certain improvements in batteries have been devised and patented by William C. Banks, of New York, N. Y. (787,715, April 18, 1905). The invention relates particularly to primary batteries, and it consists, essentially, in certain features of construction whereby the device is rendered susceptible to ready and easy cleaning and recharging, while at the same time it accomplishes a continuous, even and long discharge of current. A jar is provided, and a standard which supports the remaining parts of the battery. This standard has a tube portion supported above the bottom thereof. A zinc is supported on the standard. A



Battery.

basket is located substantially concentric with the tube located above the zinc. Terminals are provided, one of which leads down through the tube and to its appropriate element.

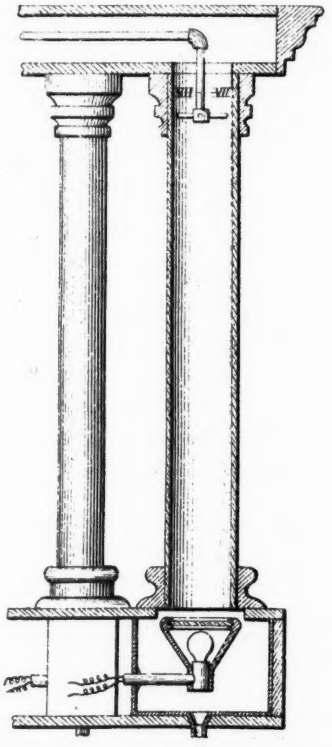
Arthur C. Eastwood, of Cleveland, Ohio, is the inventor of a motor-starting device (787,738, April 18, 1905). The object of the invention is to provide a motor-starting device of relatively simple construction and operation which shall require merely the closing of the switch



Motor-Starting Device.

to safely start the motor with which it is in circuit. It is also the object to provide motor-starting means which will at all times automatically act to protect the motor, particularly in the event of cutting off of current from it and the subsequent re-establishment of the current supply, it being desired that the device shall operate to automatically start the motor upon such restoration of the current flow. A motor is provided having in series with it an inductive starting resistance in addition to its own field-windings. A switch is employed provided with means tending to maintain it in an open condition, said switch being in shunt to the starting resistance. A coil is employed for operating the switch, the ends of the coil being connected respectively to the armature terminals of the motor.

Jesse T. Evans, of St. Louis, Mo., has invented a system of decorating, whereby decorative effects may be produced in the walls of buildings or other structures, the system comprising, essentially, transparent wall-surfaces over which or in



System of Decorating

the rear of which water is caused to flow and means whereby rays of colored light are projected into the transparent wall-surfaces and water for the production of an illuminated decorative effect (787,616, April 18, 1905). In carrying out the invention, a transparent column is employed within which is mounted a rotary sprayer. The sprayer is located near the top of the column and throws water therefrom on to the inner surface of the column in a downward and outward direction. A lamp is arranged at the bottom of the column. Surrounding the lamp is an inverted cone-shaped reflector, which reflector directs the rays from the light upwardly. Over this reflector is arranged a transparent top.

Lectures on Electricity in 1751.

At the Boston Art Club an extensive collection of Americana belonging to R. Henry W. Dwight, Esq., president of the Sons of the Revolution, forms an exhibition of particular interest to persons of antiquarian tastes.

Among these is an interesting broadside, which gives a summary of two lectures on electricity by Ebenezer Kinnersley delivered in Faneuil Hall in September, 1751—the first lectures probably ever delivered on the then new subject of electricity. Kinnersley was an Englishman, who was head master in English literature in the College of Philadelphia, from 1753 to 1773, a student of science, who made a number of discoveries in electricity and invented a number of quaint electrical devices. He and Franklin were on intimate terms, and were closely associated in their electrical experiments. Kinnersley has been erroneously cited as an anticipator of Oersted's discovery of the deflection of a magnetic needle by an electric current. The former's experiment, however, was purely electrostatic. In the summary of these two lectures, among other things, it states that electricity "is an extremely subtile fluid."

"That it doth not take up any perceptible time in passing through large portions of space.

"That it is mixed with the substance of all other fluids and solids of our globe.

"That our bodies at all times contain enough of it to set a house on fire."

He exhibits:

"An artificial spider animated by the electric fire so as to act like a live one.

"A shower of sand which rises again as fast as it falls.

"A leaf of the most mighty of metals suspended in the air, as is said of Mahomet's tomb.

"Electrified money which scarce anybody will take when offered to them.

"A curious machine, acting by means of the electric fire, and playing a variety of tunes on eight musical bells."

This broadside of 1751 appears to antedate any other similar notice of electrical experiments.

The ELECTRICAL REVIEW of April 23, 1904, page 621, published copy of an advertisement from the Massachusetts *Gazette*, of March 7, 1765, giving notice of a course of lectures by David Mason, illustrated by "entertaining experiments on electricity similar to those cited in the broadside under date of 1751."

It may be wondered whether any one will find an earlier citation of "electricity is in its infancy" than that of George Adams in 1792, and yet who can question the propriety of using the adage to-day?

Dinner to the Swedish Delegates to the International Railway Congress.

The American Society of Swedish Engineers tendered a reception and dinner to the delegates from Sweden and Norway to the International Railway Congress. The dinner was given in the clubhouse, 231 Union street, Brooklyn, N. Y., on Friday evening, April 26. The Swedish government railways were represented by Victor Klemming, of the board of directors and chief of the rolling stock department; A. Corin, traffic manager; Hjalmer Vikland, chief of permanent way and works; I. Petterson, engineer of permanent way and works department; Harald Lemcke, district manager. Other gentlemen present were F. W. H. Pegelow, managing director, and Th. George Betts, chief of motive power department of the Stockholm Westeras-Bergslagens Railway; Captain Victor Stahle, general manager of the Stockholm-Rimbo Railroad; Mr. John Johnson, managing director of the Frovi Ludvika Railroad; E. Sunde, managing director and minister of finances of the Norwegian state railways.

The delegates were escorted from the Manhattan Hotel, New York city, to the clubhouse by a reception committee consisting of Mr. G. P. Wern, C. J. Mellin, H. Fernstrom, J. H. Hallberg and F. Clarholm.

During the dinner many references were made by the Swedish delegates to the electrification of the state railways, and it was also stated that results will soon be available of the experimental tests of the high-voltage, single-phase locomotives which have been purchased by the Swedish government.

At the close of the dinner Mr. Fernstrom extended an invitation to the delegates to participate in a tour of inspection, on Saturday morning, of the new developments carried out by the New York Central & Hudson River Railroad.

Annual Meeting of the Technical Publicity Association.

The annual dinner of the Technical Publicity Association was held in New York on April 27. The organization represents over thirty large manufacturers. The members of the association, nearly all of whom were in attendance at the dinner, are Philip P. Kobbe, Rand Drill Company, president; H. M. Cleaver, Niles-Bement-Pond Company, vice-president; C. B. Morse, Ingersoll-Sergeant Drill Company, second vice-president; George H. Gibson, International Steam Pump Company, secretary; H. M. Davis, Sprague Electric Company, treasurer; Rodman Gilder, Crocker-Wheeler Company, and Graham Smith, Westinghouse Companies, executive committee; H. T. Lauretzen, Holophone Glass Company; F. S. Wayne, Robins Conveying Belt Company; Lucius I. Wightman and Fred C. Iglehart, Ingersoll-Sergeant Drill Company; J. C. McQuiston and J. O. Little, Westinghouse Companies; C. P. Hutchins, Joseph Dixon Crucible Company; F. C. Cheston, American Wood Working Machinery Company; Dean Park, Hammacher, Schlemmer & Company; F. R. Matthews, De La Vergne Machine Company; Dixon Boardman, Hall Signal Company; F. H. Gale, General Electric Company; C. S. Redfield and R. R. Glenn, Yale & Towne Manufacturing Company; A. E. Michel, International Steam Pump Company; A. N. Barber, John A. Roebling's Sons Company; W. B. Snow, B. F. Sturtevant Company; E. F. Schaefer, Rand Drill Company; H. H. Kress, Cameron Steam Pump Works; F. B. Vail, American Air Compressor Works; Arthur Warren, Allis-Chalmers Company; A. E. Newton, Cutter Company.

Mr. Emerson P. Harris presented an address on "The Machinery for Marketing Machinery."

An Electrical Speed Indicator.

A simple, and what seems to be a useful electrical speed indicator has been invented by M. Carlier, and is now being constructed by the Siemens & Halske Company, of Berlin. A description of the device is given in *Electro*, Brussels, for March. This device is similar to the well-known Owens speed indicator, except that an alternator is employed in place of the direct-current machine used for the latter. The device consists of a small alternating-current generator with a revolving field. The armature consists of two coils wound over projecting poles, this winding being similar to the field winding of a small direct-current motor. The revolving field consists of a permanent magnet of the horseshoe type, having soft iron pole-shoes attached to its extremities. The machine is driven by means of a cord or other suitable device, and the speed is determined by the voltage set up, an alternating-current voltameter being used for this purpose. The indicator can be placed at any point, but has the disadvantage that it can not be used to indicate accurately wide variations in speed without a readjustment of the arrangement.

Reviews of Current Engineering and Scientific Literature.

Interrupters for Induction Coils.

A brief review is here given of the different types of interrupters used in connection with induction coils, and some experimental results are shown indicating their relative value. The simplest type is the revolving contact-maker having an insulating segment inserted, which breaks the circuit once or twice during a revolution. This device is simple and clean, but deteriorates on account of sparking. It is far more effective when operated at a high speed than at low speed. The double-dipper interrupter consists of two cranks on one shaft, each of which sets into motion a point dipping into mercury. Two points are used, so as to obtain two breaks per revolution. This is a good arrangement, but it is not as satisfactory as the mercury jet interrupter, which consists of a toothed cylinder driven by a small motor, which, at the same time, drives a small mercury pump, the discharge from which is directed against the revolving cylinder. Two types of electrolytic interrupter are shown also, and their construction described briefly.—*Abstracted from Nature (London), April* 6.

A Proposed Method of Investigating Earth Currents.

After giving a fairly complete review of the investigations of earth currents, Mr. J. E. Burbank proposes a method for investigating them more accurately. If two earth plates are sunk in the ground, a current may pass through the wire connecting them, due to a potential difference of the soils at the two points; or the current might be the result of chemical action between the cells and the plates. This effect could be overcome partially by using non-polarizable electrodes. Another cause which might bring about the flow of current would be the circulation of atmospheric electricity. The air usually contains an excess of positive electrification, so that there should be an upward convection current with a low barometer, and a downward current with a high barometer, the circuit being completed by the earth in the upper strata of the atmosphere. Induction currents might be set up, due to variations in the earth's magnetism, or the rotation of the earth in a varying electric field. The first two causes give what is known as the constant part of the current, the second two giving the variable parts; and it is important to be able to separate these parts. Mr. Burbank says that more accurate determinations of the resistance of the soil and its variation of moisture, freezing, etc., are highly desirable; that the electromotive force due to chemical action between the earth plates and the surrounding soil should be determined by means of a normal electrode; that soils from different places should be collected, and the miniature line constructed entirely isolated from the earth. Then, with the aid of a chemical analysis of the soil, it would be possible to select non-polarizable electrodes for each soil. To determine the effect of atmospheric electricity, observations should be made, especially on the conductivity and potential of the air. A continuous record should be made of the earth current, and, for this purpose, a sensitive galvanometer with a suitable damping arrangement, and a fairly short period of swing, should be used. A photographic record should be made of its deflections. By the use of a potentiometer, the steady part of the current might be compensated for, leaving the record of the variable part only. Two such circuits should be constructed, one orientated north-south, and the other east-west, the record being obtained on the same cylinder. A third circuit, entirely isolated from the earth, and consisting of several turns of wire lying in a horizontal plane, and enclosing as large an area as convenient, would furnish a means of studying the variation of the vertical component of the earth's magnetism. It is doubtful, however, if such a circuit would give very satisfactory results, as the changes to be detected are slow. The large number of other influencing factors should be observed at the same time, such as the factor of wind, sunlight, and the radioactivity of different soils.—*Abstracted from Terrestrial Magnetism and Atmospheric Electricity (Baltimore), March.*

The Church Stretton, England, Gas-Driven Electricity Works.

The small generating station described here is interesting chiefly from the type of prime mover employed. It is one of the few suction-gas-driven plants in England used for public electricity supply purposes. In the engine room there are two eighty-brake-horse-power gas engines running at a normal speed of 200 revolutions per minute, and each driving, through a fourteen-inch belt, a fifty-kilowatt, shunt-wound dynamo. The engines are provided with balanced cranks, and the connecting rod big ends are of the marine type. The flywheel ends of the crank shafts are carried on the outer bearings, the flywheels themselves being eight feet nine inches in diameter, with belt faces eighteen inches wide. Magneto-electric ignition is employed, and self-starters are used for filling the cylinders with gas at a lighting pressure when starting up. The engines are mounted on what is practically a floating concrete foundation. The latter is a solid block of concrete, and rests on a layer of cocoanut fibre six inches thick, which, in its turn, rests on the general concrete foundations of the building. The cocoanut fibre is packed on all sides of the foundation. This arrangement absorbs effectively all engine vibrations. Behind each engine, in connection with the air inlet valve, is an air suction box containing a straining medium for filtering the air drawn into the cylinder. Two suction gas producers of the Dowson type are installed in the producer house behind the engine room. The fuel used is anthracite pea, which is fed into the hopper at the top of the gas generator, in connection with which is a small hand-driven fan installed for blowing up the fire when starting. The steam supply from the vaporizer can be varied at will for altering the composition of the gas, according to the load on the engine. The gas has a calorific value of about 150 British thermal units per cubic foot. In practice, the fuel consumption is said to be less than one pound of anthracite per brake-horse-power-hour. The gas passes through a scrubber, which consists merely of a chamber containing small coke, with a water sprinkler arranged in the top. Once the requisite quality of gas is obtained, and the engine started by means of the hand-starter, the gas production is maintained at exactly the requisite rate through the suction exercised by the engine. An advantage of this system of working is that the gas generator works under a negative pressure, so that no leakage takes place. Besides the two dynamos mentioned above, the station contains a battery consisting of 230 cells, capable of supplying 220 sixteen-candle-power lamps for nine hours. The battery is controlled by a motor-driven booster.—*Abstracted from the Electrical Review (London), April* 21.

Burning Out of Electric Street Car Controllers.

Mr. Sydney W. Ashe here discusses the question of the burning out of a street car controller when the safety devices, such as circuit-breaker and fuses, are in proper condition. The burning out of a controller invariably starts with an arc, which jumps to the grounded controller casing, forming a circuit from trolley to ground. Protective devices, under these circumstances, may be in normal proper working condition, or the circuit-breaker may be set high, in which case reliance is placed upon the fuse to protect the circuit. An arc, jumping to a grounded controller casing, may form a direct short-circuit or a partial short-circuit. In the latter case, the arc forms between a resistance finger of the controller and the casing. In this case, the magnitude of the arc, following the grounding of the circuit, depends upon the amount of the series car resistance forming a part of the circuit, and it seems quite possible, in such a case, for an arc of 175 amperes to continue, if the line pressure is 500 volts. The arc will gradually melt the contact fingers and casing until a direct ground is formed, when the current will be in excess of 175 amperes, and a circuit-breaker set for 250 amperes would open. The duration of such a burning-out process, however, would be sufficient to severely damage the controller. The fuse and circuit-breaker could be in a normal condition, and the controller could still burn out if the arc were to form in the above manner. An experiment was performed, in order to determine the behavior of an arc during the interval of time that elapses for a fuse in circuit to blow. A hand-feed arc lamp was connected in series with a 100-ampere ammeter, a fifty-ampere fuse, a regulating rheostat, and a 115-volt service. The rheostat was shunted by a switch, so that it could be short-circuited at will. An arc was sprung between the carbons, and the rheostat adjusted until fifteen amperes was flowing in the circuit. Upon closing the short-circuiting switch, a current of 100 amperes passed through the arc, the fuse blowing shortly afterward. During the interval that elapsed before the fuse blew, there was a discharge between the two carbons which was about twelve inches in length. The conclusion was arrived at, that the controller would be burned out before the fuse could blow, providing the circuit-breaker were set high or were caught. In discussing a remedy for this trouble, it is pointed out that controllers will burn out as long as the main line current is interrupted in the controller case, but that the danger is reduced to a minimum if the controllers are frequently inspected and kept thoroughly clean. Arcs, however, are bound to form whenever metallic dust, oil or gritty matter accumulates, or when the blowout magnet becomes short-circuited. The only way to eliminate entirely the burning-out trouble is to use as a controller a modified form of the contactor system of control employed for heavy traction work, in which the heavy train line circuits are opened and closed by perpendicular-break contactors located underneath the floor of the car. With this form of control, a local current of small value passes through the master controller operated by the motorman, this current governing the operation of the main contactors, and being of such small magnitude as to cause no trouble.—*Abstracted from Engineering News (New York), April* 20.

The Theory of the Electrolytic Rectifier.

A rather exhaustive study of the electrolytic rectifier has been made by Mr. S. R. Cook, who has also contributed previous communications discussing this device. In the present article he describes the particular apparatus which he has used in his latest investigations, and gives data collected during the experiments. He concludes with some interesting remarks on the possible theory of the electrolytic rectifier. Whenever oxygen is the primary or secondary product of the anion, the aluminum anode is covered with a film of hydroxide which has a very high resistance—so high, indeed, that it acts as a dielectric to the charge on the ions. This non-conducting film between the metallic aluminum and the electrolyte produces a condenser effect, with negative charge on the anions of the electrolyte. The conditions that likewise exist when a direct current is applied to an electrolytic rectifier are that, when any potential less than the critical potential is applied, there is introduced an equal and opposite charge in the electrolyte next to the respective electrodes. When the current is broken there exist compound charges in the electrolyte and on the electrodes, which may be assumed to be equal to each other. The curve of decay shows the rate at which these charged ions pass through the film. When the current is reversed, the hydrogen ions pass through the film more readily than the oxygen or other negative ions, forming a gas between the metallic aluminum and the film, thus breaking away the film and exposing the metal to the charged ions. When an alternating current is applied, the film acts as a semi-permeable membrane. The hydrogen atoms, having less mass and greater velocity than the oxygen or other negative ions, pass through it more freely than the slowly moving anions. The critical potential value for an electrolytic rectifier depends upon the electrolyte used and the temperature of the cell. When the critical potential has been passed, the film crystallizes, and, in crystallizing, exposes the metallic aluminum. There are two potentials, depending upon the temperature at which the film undergoes a change such that its resistance to the passage of the ions is decreased, the first being at a potential whose value is about one-third the value of the second. The second is at the point where crystallization takes place.—*Abstracted from the Physical Review (London), May.*

The Electrolytic Preparation and Production of Calcium, Strontium and Barium.

In this article Dr. F. M. Perkin gives a brief historical sketch of the different processes which have been devised for producing metallic calcium, giving somewhat in detail that due to Plato and Ruff, by means of which calcium may be manufactured commercially. He dwells briefly upon the properties of calcium which make it valuable, and then describes recently devised processes for producing strontium and barium. Borscher and Stockem prepare metallic calcium by electrolyzing fused strontium chloride in a vessel, the bottom of which consists of fire-clay, and the sides of a hollow cylinder of carbon. The carbon cylinder forms the anode. The cathode is an iron rod projecting up through the fire-clay. A water bath is provided to cool the fire-clay base of the electrolyzing vessel. Metallic strontium collects in large globules at the bottom of the fused electrolyte, and is obtained by removing the salt after it has solidified, and crushing. Metallic strontium has much the same appearance as calcium. It is about as white as zinc, and as soft as lead. As yet there is no commercial process for producing metallic barium, although Davy has obtained it in the form of an amalgam.—*Abstracted from the Electrical Magazine (London), April.*

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

New Westinghouse Electrical Apparatus.

The recognized necessity of making frequent tests of incandescent lamps to ensure of their working under the best efficiency and to facilitate their removal from the circuit when their illuminating intensity has dropped below a certain standard has created a demand for a portable lamp-testing apparatus which would combine all the elements requisite for a determination of the watts consumed by the filament and at the same time the voltage of the particular circuit upon which the lamp might be working. The instrument shown in Fig. 1 has been designed especially for this work. In effect, it is a portable wattmeter, provided with a socket or receptacle for the introduction of the lamp to be tested, and with a switch

FIG. 1.—PORTABLE LAMP-TESTING APPARATUS.

for cutting out the series windings, in order to enable the instrument to be used as a voltmeter, operating on the voltage winding alone. Connection is made by means of a pair of leads, the upper ends of which unite in a plug to be screwed into the lamp socket on the lighting circuit, and the lower ends being provided with terminals for attaching to the binding-posts. It requires but a moment to make the connection. When used in lighting installations, the lamp to be tested is removed from the line and inserted in the receptacle on the volt-wattmeter, which is then connected to the socket from which the lamp was taken, and a test is made under the conditions which exist in service.

Two concentric scales are provided, one indicating volts and the other watts, and by use of the switch which cuts the series winding in or out of the magnetic circuit the wattage of the lamp or the voltage of the circuit may be read. This is a feature not possessed by any other lamp tester's instrument, and makes it unnecessary to carry a voltmeter.

Lamp-testing instruments heretofore designed have been wattmeters only, and it has been necessary to use voltmeters in connection with these wattmeters to obtain reliable results, as the watts vary more rapidly than the square of the voltage, and it is insufficient to know merely the watts the lamp consumes.

The instrument may also be used either as a voltmeter or a wattmeter, independently of its lamp-testing function, which gives it an additional value and adopts it for general testing purposes. It is suitable for use on either alternating or direct current without change of calibration. Reverse readings are not necessary on direct currents.

This volt-wattmeter combines the advantages of portability, ease of manipulation, long range of readings and accuracy. It is mounted in a polished mahogany case six and three-fourths by seven and three-fourths by four and three-fourths inches and has a removable cover. The scale is long, with large, open divisions, easy to read. The action is dead-beat. The instrument operates on electromagnetic principles, having two light, movable coils connected to the indicator and four stationary coils connected in series, the arrangement being such as to practically neutralize the self-induction of the system. It is not affected by external fields or changes in frequency, and has powerful spring, giving ample governing force. It has a maximum capacity of 150 volts and 150 watts, which is ample for the service for which it is designed.

A new direct-current integrating wattmeter, Fig. 2, has been developed. Integrating wattmeters for alternating-current service have been made by the Westinghouse Electric and Manufacturing Company since such instruments were first introduced, and the characteristics of the Westinghouse type have become very generally known. Its design is the result of an exhaustive series of tests of each and every factor which affects its performance and of the large experience gained in the manufacture of other meters.

In general appearance the new instrument resembles the Westinghouse alternating-current integrating wattmeters. The case is finished in black enamel, with letters in low relief. The terminals enter at the sides, passing through the case, the line wires being connected on the right-hand side of the meter and the load wires on the left, the upper wire line being the positive. To make connections, it is only necessary to bare the ends of the wires, to insert them in the bushings of the sides of the case and to tighten the binding screws. The bushings form a close junction with the terminal blocks, and make

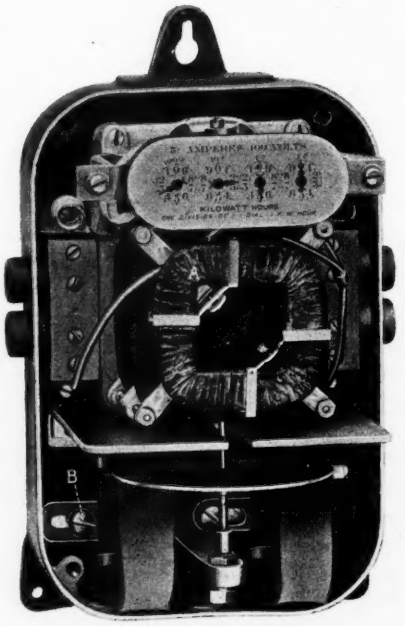


FIG. 2.—DIRECT-CURRENT INTEGRATING WATTMETER.

the case as insect and moisture-proof at this point as at all others.

By removing the cover, as shown in Fig. 2, all parts of the mechanism are exposed. The adjustments, which are wholly mechanical and do not depend upon variable resistance or similar arrangements, can then be easily made. To compensate for friction, the shunt coil shown at A in Fig. 2 is moved in or out, this coil being held in position by two screws which clamp against brackets as shown.

The speed of the disc is controlled by two permanent magnets, so mounted as to secure perfect alignment. Moving the magnets in from the edge of the disc increases the speed, and moving them out toward the edge decreases the speed, at any given load. Releasing the adjusting

screws, one of which is shown at B in Fig. 2, permits the magnets to be moved as required.

The lower bearing of the shaft is of the cup-and-ball type, the same as that used in Westinghouse integrating wattmeters for alternating current which, the maker states, has thoroughly demonstrated its value in reducing wear and friction. The shaft terminates in a removable sleeve with a slightly cupped sapphire jewel which rests upon a hardened steel ball one-sixteenth of an inch in diameter. This ball is supported by a second jewel, similarly cupped, which is set in the end of the adjusting screw which forms the lower half of the bearing.

FIG. 3.—CIRCUIT-BREAKER, CLOSED.

The lower jewel is spring-mounted, a construction which effectually protects it against sudden jar. The steel balls and jewels undergo a special polishing process and are rigidly inspected before using.

The very slight friction of a bearing of this form ensures the motor remaining in calibrations at light loads and this feature, combined with the reduced weight of the moving element, affords a much-lengthened period of active service for this meter than for others.

The commutator is an important part of all direct-current wattmeters, and requires the use of non-oxidizing metal and a diameter small enough to minimize friction. Especial attention has been given to this feature and it has been fully developed in every respect, the diameter being only five-sixty-fourths of an inch,

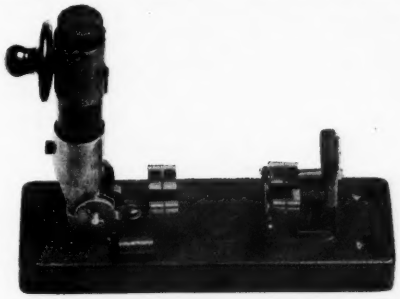


FIG. 4.—CIRCUIT-BREAKER, OPEN.

which ensures a reduction of friction to a minimum.

A perfect commutator is ineffective, however, without suitable brushes, so this feature has been made a subject of special study. Perfect contact with the least amount of friction must be maintained, and the material must be such that oxidization will not take place. The brushes in this meter are composed of a number of strands of wire of non-oxidizing material. This subdivision of the brush gives an excellent contact, as each strand is thereby made a separate brush and the series of strands conforms exactly to the surface of the commutator with less total tension, ensuring ideal working conditions.

A compact and inexpensive circuit-breaker, Fig. 3 and Fig. 4, designated as type F, has been placed on the market, for both alternating and direct-current circuits. The type F circuit-breaker is made in twelve and one-half, twenty-five, fifty and seventy-five-ampere sizes for 250 volts direct and 440 volts alternating. They are made in the overload type only. The tripping point is adjusted by turning the thumb screw shown in the illustration, the range being from eighty per cent to 180 per cent rated capacity. The small insulating knob at the right of the contacts controls a tripping device, by raising which the breaker may be opened by hand. By installing a breaker for each wire of the circuit, two for two-wire and three for three-wire circuits, the switch may be dispensed with and the circuit operated by means of the breakers alone. In this case, the breakers are non-closable on overloads, the breaker on one side of the circuit opening when the breaker on the other side of the circuit is closed. An insulating knob is provided for closing. The only depth required in the containing-box is that required for the opening of the breaker. Current-carrying contacts are of copper, arcing contacts are carbon and are readily renewable. The lever-arm is opened by a spring. The operating solenoid is inside of a fibre tube in the lever arm, which also conduces to a small and compact design. The parts of the breaker are mounted on a neat porcelain block, which is fastened to its support by three screws with countersunk heads.

The well-known Westinghouse Electric and Manufacturing Company Wurts non-arcing arrester has been in service now for over twelve years, and it is notable in this connection that the first changes in its mechanical mounting have only recently been found desirable.

The new type, Fig. 5 and Fig. 6, has the same dimensions as the old type C arrester, style No. 1383, and the arrester unit itself may be used as a repair part wherever this device has been employed. One improvement is the method of securing the non-arcing cylinders to the porcelain supports. These are firmly held in place by machine screws passing through

FIG. 5.—NON-ARCING ARRESTER COMPLETE.

holes in the porcelain supports and screwed in the line and ground contacts. Porcelain supports are moulded to shape with the cylinder centres exactly spaced, thus securing a perfect air-gap adjustment. All the cylinders can be easily turned through any angle to present new surfaces for action. Line and ground leads are made in a very secure manner.

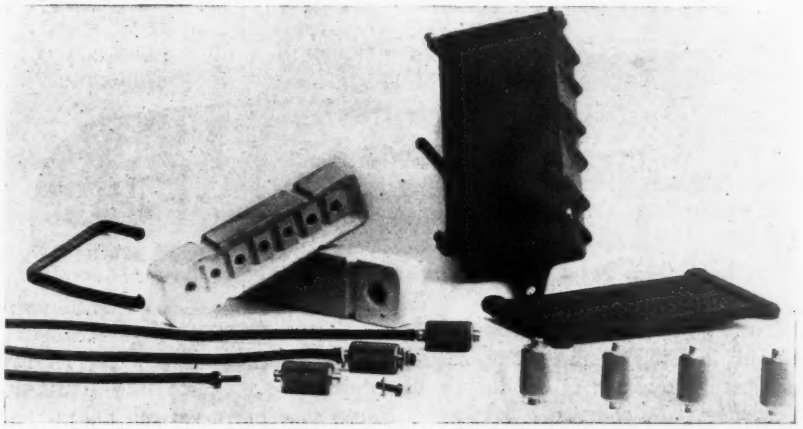


FIG. 6.—PARTS OF NON-ARCING ARRESTERS.

The assembled porcelain supports and cylinders are separated from the iron box by rubber-covered wire. This makes an effective packing which ensures the porcelain from breakage if the arrester be shaken or jarred, and the wire holds the packing in place.

The cover is screwed to the box, rubber gaskets keeping out all rain. The arrester is of the line type designed for connection to overhead feeders and circuits, the normal rating being from 500 to 1,250 volts double-pole and up to 2,500 volts single-pole.

All the best electrical operating characteristics of the old type C arrester are retained, the improvements consisting of improved mechanical construction and consequently longer life and ease of inspection and repair.

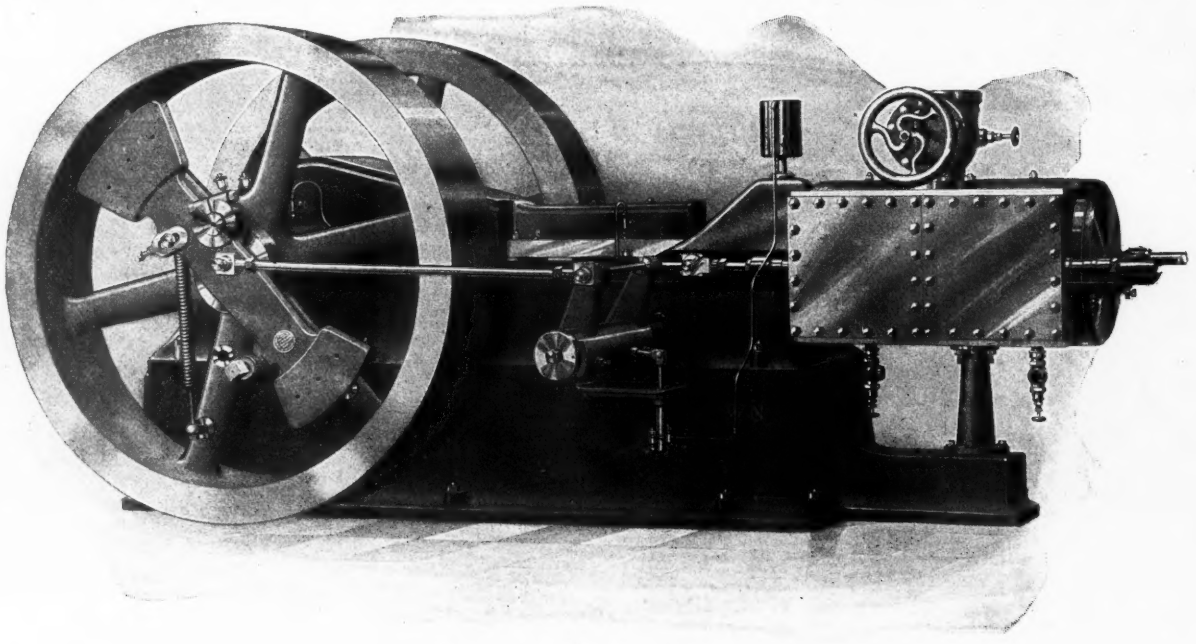
Watertown Four-Valve Engine.

The Watertown Engine Company, Watertown, N. Y., has developed a new four-valve, high-speed engine, which is shown in the accompanying illustration. The steam valves are placed on one side of the cylinder, and are controlled by the governor. The exhaust valves are on the opposite side of the cylinder, and are driven by an adjustable eccentric. The construction of the engine is such that the live steam in the steam chest is in close contact with the cylinder walls before passing through the valve. In this way the cylinder walls are maintained at a uniformly high temperature. The exhaust steam passes from the valves directly to the exhaust pipe, and is not allowed to come in contact with the cylinder walls. The partial jacketing of the cylinder walls with live steam, and the prevention of the cooling contact of the exhaust steam, are features of the engine to which the maker desires to call particular attention.

The valves are flat, double-ported, and balanced under well-stiffened pressure plates. They are light and easily driven. The clearance in the engine is extremely small. The port through the cylinder wall is of a length only necessary to give proper strength to the cylinder. The passage in the valve itself is as short and direct as possible. The valve rods are supported at both ends of the steam chest by guide sleeves, and the connections with the valves are short and direct. The subbase extends the entire length of the engine. It is cut away, however, underneath the cylinder, in order to permit easy access to the drips and exhaust connections. The cylinder is supported by a post running down to the subbase.

The oiling system is the same as that which is used in the smaller engines made by this company. The flow of oil is carried from a reservoir to any convenient point, and from there it is fed by gravity through pipes concealed in the frame to the points required. It then flows through sight-feed regulating valves to the wearing surfaces. It is drained into the crank pit through a filter concealed in the frame. The filter may be removed for examination or cleaning at any time. After passing through the filter the purified oil flows to a pump beneath the rocker, and is forced back to the supply reservoir. The flow of oil to any part of the engine can be regulated.

The engine is extremely heavy in construction, and the wearing parts exceedingly simple in design. It is built in sizes from 150 horse-power and upward in simple engines. Engines of 250 horse-power and over are made compound.



WATERTOWN FOUR-VALVE ENGINE.

Consolidation of the Stanley Electric Manufacturing Company and the General Incandescent Arc Light Company.

The Stanley Electric Manufacturing Company, Pittsfield, Mass., and the General Incandescent Arc Light Company, New York city, have consolidated. The new title of the combined interests will be "Stanley-G. I. Electric Manufacturing Company." The Stanley company, as engineer and manufacturer of the well-known "S. K. C." system, has acquired the reputation of turning out only absolutely reliable electrical apparatus. The "S. K. C." system embraces the latest developments and improvements in generators, transformers, rotary converters, motor-generators, switchboard apparatus, induction motors, etc.

The General Incandescent Arc Light Company is well known as the builder of high-grade arc lamps, incandescent lamps, alternating-current and direct-current motors, and general electrical supplies. The engineers of this company have for years made a special study of electric lighting.

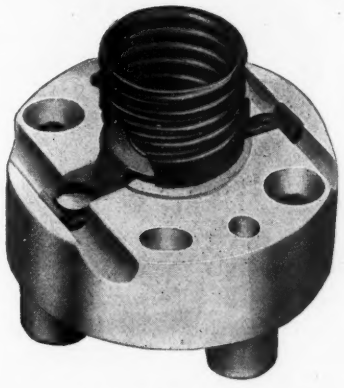
The officers of the Stanley-G. I. Electric Manufacturing Company are William Murray Crane, president; C. C. Chesney, first vice-president; M. D. Barr, second vice-president; M. J. Insull, third vice-president.

Dixon Crucible Meeting.

At the annual meeting of the stockholders of the Joseph Dixon Crucible Company, Jersey City, N. J., the old board, consisting of Edward F. C. Young, John A. Walker, Edward L. Young, William Murray, George T. Smith, Joseph D. Bedle and George E. Long, was unanimously reelected. The board of directors reelected the former officers, namely, Edward F. C. Young, president; John A. Walker, vice-president and treasurer; George E. Long, secretary. Judge Joseph D. Bedle was also reelected as counsel.

Newcode Receptacle.

The Newcode receptacle which is being introduced by Stanley & Patterson, New York city, has been designed to take the place of all open-contact receptacles which, with their exposed terminals, unsatisfactory insulation qualities—because of centre screw, etc.—have been objection-



NEWCODE RECEPTACLE.

able to the majority of the Underwriters' boards in the country.

They desire to call particular attention to the following advantages of the receptacles:

Newcode receptacles have no exposed contacts, and require no soldering of wires to terminals and no taping or painting after connecting. They have four porcelain legs of sufficient height to do away with the old method of building up on porcelain insulators.

The receptacles have spring centre contacts made of phosphor-bronze. The shells are removable by simply taking out two screws. Phosphor-bronze shells are used likewise, so that both contacts are phosphor-bronze in place of the ordinary cop-

NEWCODE RECEPTACLE HOUSING CAP.

per. Five per cent phosphor-tin added to copper is commercially called phosphor-bronze, and means 400 per cent increased life over copper, when exposed to weather.

The centre contact spring puts a slight pressure on the lamp thread, preventing, after the lamp has been screwed home, any possible jarring loose of the lamp. It also ensures absolutely perfect centre contact.

A Newcode receptacle, after once being connected and placed in position, has a porcelain housing cap completely covering all live terminals; the neck of the porcelain cap closely surrounds the neck of the lamp and comes up high enough to effectually guard the butt of the lamp from metallic contact after it has been screwed into the receptacle. Nuts on the back of the receptacle are punched out of one-sixteenth-inch brass, thus giving ample thickness for thread in the nuts; the nuts are square, fitting into the square recesses of the porcelain closely; porcelain walls separate each nut.

The receptacles have binding screws with upset ends, permitting the loosening up of all screws before the receptacle is placed in position. This also permits wires being run along rapidly with no danger of screws falling out. The holes, where the brass connection screws pass, are drawn up so that the metal at this

NEWCODE RECEPTACLE, COMPLETE.

point is nearly double thickness. This permits four full threads, making the thread always safe against stripping.

Newcode receptacles are approved and endorsed by the National Board of Fire Underwriters, the New York department of water supply, gas and electricity and the New York Board of Fire Underwriters.

The Luminous Radiator.

The new and attractive heating device shown in the accompanying illustrations, Figs. 1 and 2, is likely to prove very popular. It is equipped with three large incandescent heating lamps, which glow brightly and throw out a powerful heat. Its cheerful appearance gives it a great advantage over non-luminous radiators and it should be in great demand by the large number of people who are glad to pay for comfort and convenience.

These radiators consume a trifling amount of power for the service they give, and are especially advantageous for giving temporary heat on chilly days, when it would not pay to start a fire in the house for the sake of warming one or two rooms. They replace to advantage the old gas log and similar devices, and should find a ready sale in cases where neither oil, gas

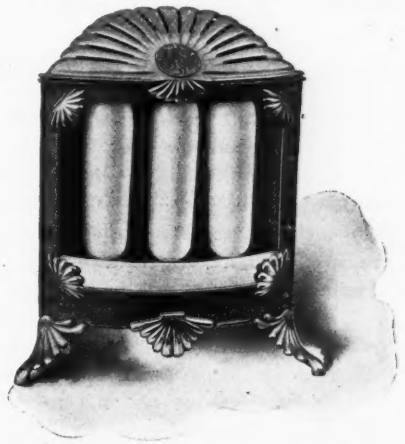


FIG. 1.—PORTABLE LUMINOUS RADIATOR.

nor coal would be considered. Instead of vitiating the air and introducing fire danger they warm the air by simple radiation from a source that is safe, clean and odorless.

The luminous heater is as portable as a footstool, and may be placed in any corner of the room. Its finish—bright copper reflector and oxidized copper frame—harmonizes with any surroundings. If preferred the heater may be installed permanently in the fireplace, as shown in Fig. 2.

The General Electric Company is now ready to fill orders for these luminous heaters. Several of the heaters will be shipped to each of the district offices of

FIG. 2.—PERMANENTLY LOCATED LUMINOUS RADIATOR.

the company, where they will be placed on exhibition.

For use where a strong heat is required and ornamental features may be dispensed with another style having two heats, with a maximum consumption of 1,500 watts, and containing four heater lamps in a plain black iron body, is nearly ready for the market.

Combination Gasoline Soldering-Iron and Blow-Torch.

The Emmelmann Brothers Manufacturing Company, Indianapolis, Ind., is successfully introducing on the market a patent combination automatic gasoline soldering-iron and blow-torch illustrated herewith. In operation, the cap at A is removed and the magazine is filled with gasoline to within one-half inch of being full; then the cap is screwed on firmly. The alcohol lamp which accompanies each tool is lighted and the iron is heated at B for at least three minutes in a slanting position with the head down, keeping the valve C closed to generate a hot gas pressure. After heating B the stated time, the valve is gently opened and lighted by passing the tool over the flame at F. The tool should continue to be heated at B for three minutes more; the operator can regulate the blast to suit the work to be done by means of valve C. If the work is being done outside in a heavy wind or the tool is used as a blow-torch

COMBINATION GASOLINE SOLDERING-IRON AND BLOW-TORCH.

the shutter at B should be closed. The soldering copper is universal. Any shape copper point can be used. By removing the copper point shown at E the tool can be used as a blow-torch. Should the tool not work readily, the steel head shown at F can be unscrewed and the small hole in the centre of plug cleaned with a fine wire; the hole, however, should not be enlarged.

The device will last an unlimited length of time if properly taken care of. It is well constructed; not complicated; and easily operated and kept clean. When properly started, it is claimed that every particle of gasoline is consumed in a hot gas form without any danger of explosion and can be refilled without generating. The cost to keep the tool in constant operation is said to be only about five cents a day. This tool is being used by electricians, linemen, tinners, plumbers and painters. Among its merits are, that it is never too hot or too cold, while the strongest wind will not blow it out. The tool is furnished with two drop forge coppers, one for regular work and one for heavy work; the head is a high-grade steel casting. The cylinder is made of sixteen-inch gauge drawn brass tubing, threaded at both ends. The joints are tinned and sweated. A blunt brass valve stem is used; the valve is made of the same material, reducing grinding, binding and leakage to a minimum.

A New Outlet Box.

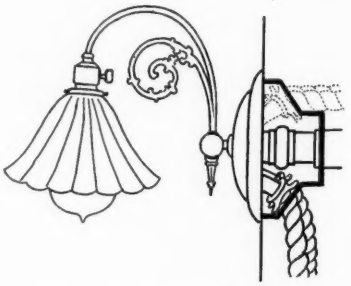
The accompanying illustrations show the new form of outlet box brought out by the Sarco Company, New York city. This box has been designated as the Sarco "competition" box, the significance of the name having to do with the utility of this box in competition with either side-wall or ceiling boxes.

This outlet box is made of cast iron, and possesses the features of the regular

NEW FORM OF OUTLET BOX FOR CEILING OR WALL.

NEW FORM OF OUTLET BOX FOR CEILING OR WALL.

Sarco outlet box for steel-armored cable. The box is so arranged that it does away with several different kinds of outlet boxes on one job. It may be used as a ceiling box or as a bracket outlet, or for a ceiling outlet. It is especially adapted for side brackets having flat canopies. The box is ordinarily furnished with the Sarco duplex flat bushing, and is arranged to have the additional outlets sealed in the manner



OUTLET BOX FOR SIDE BRACKET.

similar to that obtaining with the regular Sarco outlet box.

This box is made in three types, as follows: type "A," for straight electric; type "B," for combination to fit a three-eighths-inch gas pipe; type "C," for combination to fit one-half-inch gas pipe.

The Stirling Company's Book on Boilers.

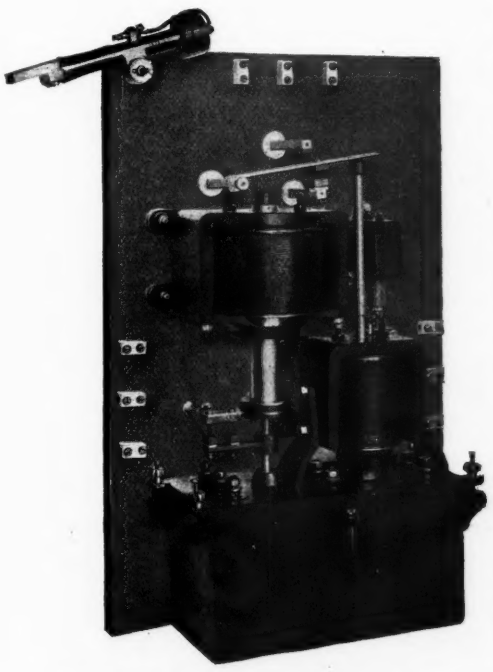
The Stirling Company, New York city, manufacturer of the Stirling water-tube boiler, has brought out a book entitled "Stirling—A Book on Steam for Engineers." This is a handsome publication bound in cloth, measuring eight by ten inches, and containing 248 pages, profusely illustrated. The first fifty pages of the book are devoted to a description of the Stirling water-tube boiler, together with illustrations of the various portions of the boiler, and photographs of various installations. The remainder of the book contains a large amount of valuable information relating to steam and to boiler operation. In the chapter on heat, a comparison of thermometer scales is given, and there is a discussion of the absolute zero and the specific and latent heats. A table of specific heats of various substances, and the boiling points of various liquids, are given, together with a table of expansions. Other chapters take up the properties of air and water, and the subject of impure feed water and scale in boilers is very thoroughly treated. The properties of steam are discussed, and a very complete steam table is given. There is a description of throttling and separating calorimeters, together with formulæ and tables for their use. Superheated steam and the flow of steam through pipes and orifices are also dealt with. One of the most valuable features of the book is a discussion of fuel. This discussion comprises about fifty pages, and takes up the various coals found in the United States, giving the best methods of burning them, together with tables of analyses and heating values. Oils, bagasse, natural gas and other fuels are also discussed. The subject of chimneys and draught is taken up in a chapter comprising twenty pages, in which a number of chimney formulæ are given and compared. In the chapter on boiler testing, the complete code of the American Society of Mechanical Engineers is given. Other subjects treated of in the book are: principles of steam piping, boiler and steam pipe coverings, boiler cleaning, directions for softening scale, troubles caused by oil in boilers, and specifications for the setting of Stirling boilers.

An Automatic Starter for Induction Motors.

The accompanying illustration shows one of the several types of automatic starters and speed controllers for induction motors recently brought out by the American Electric and Controller Company, New York city.

The starter includes an autotransformer mounted at the back of the panel or located in any other convenient place, and is for starting and stopping the squirrel-cage type of induction motors.

The illustration shows the apparatus in the full on position and the motor running. When the motor is to be stopped, it may be regulated by a float switch, such as a pressure gauge with electrical contacts, or any suitable device. The small relay at the right of the large upper solenoid is deenergized, this trips a latch and causes the main switch to open, at the same time leaving the circuits ready for starting again. To start the motor the



AUTOMATIC STARTER FOR INDUCTION MOTORS.

large upper solenoid is first energized, thus lifting the plunger and rod, and the latter connected to the transformer switch closes it. At the same time cutting off the current in the solenoid and allowing the plunger to fall very slowly against the retardation of a pneumatic dash-pot, the transformer switch still remains closed. When the plunger has fallen to its lowest point it makes the connection which energizes the lower large solenoids; the main switch is thereby closed across the line, and the transformer switch opened by the one movement, thus completing the cycle.

The starter for the slip-ring type of motor is similar in principle, but the plunger of the large upper solenoid carries a cross-arm which makes sliding contact with a straight set of contacts connected to a grid resistance in the circuit of the motor secondary, and the lower solenoid is dispensed with. An ingenious device can be added to the slip-ring type or resistance starter, making it possible to hold the cross-arm and plunger at any point along the row of contacts, thus making it serve as an automatic speed regulator as well as a starter.

Contracts for Pumping on a Large Scale.

Two very large municipal pumping engine contracts have been placed with the Allis-Chalmers Company, of Milwaukee. One is from the city of New Orleans for $500,000, the other is for the city of Pittsburg, for $350,000.

For New Orleans there will be built the most complete and up-to-date pumping plant ever erected. It will be entirely new in every respect. This plant is to pump the portable water for the city, taking it from the Mississippi river, lifting it first to great settling basins, and finally distributing it throughout the city under pressure by means of these pumps and engines, capable of supplying a total of 260,000,000 gallons a day.

For the preliminary work of lifting the water to the settling basins, there will be three Allis-Chalmers engines, direct-connected to centrifugal pumps of the same make. Each of these pumps will have a capacity of 40,000,000 gallons per day. These three engines will be horizontal cross-compound Reynolds-Corliss engines, and besides these there will be four big pumping engines, each of 30,000,000 gallons per day capacity. These four will be vertical triple-expansion crank and flywheel type.

There will also be supplied one 20,000,000-gallon centrifugal pump, and one horizontal cross-compound Reynolds-Corliss engine, as well as a 500-volt, direct-current Bullock generator, direct-connected to a horizontal cross-compound Reynolds-Corliss engine.

The Pittsburg pumping station will be supplied with two vertical compound crank and flywheel pumping engines capable of pumping 30,000,000 gallons of water daily against a head of 360 feet.

This station will also be supplied with four centrifugal direct-connected pumping units, each pump to have a capacity of 35,000,000 gallons of water per day against a forty-five-foot head. The Allis-Chalmers Company will also supply the Pittsburg pumping station with the auxiliary machinery.

Visit to Works of the Ingersoll-Sergeant Drill Company.

A party of prominent engineers and contractors, identified with the tunneling enterprises, visited the Glendon, Pa., quarries of the Ingersoll-Sergeant Drill Company, Friday, May 5, and saw in operation a new method of tunnel driving with channelers. It was of special interest on account of its availability for tunneling under the foundations of buildings, no heavy blasting being required. The guests left New York on a special train over the Jersey Central Railroad. After the visit to the quarry, they were taken to the new manufacturing plant of the company at Phillipsburg, N. J., where luncheon was served. The afternoon was devoted to an inspection of the new works. The return was then made by special train.

The party included: Chief Engineer Charles M. Jacobs and Assistant Chief Engineer Forgie, of the Pennsylvania tunnel under the Hudson river; Chief Engineer Alfred Noble, of the Pennsylvania tunnel under the East river; President John F. O'Rourke, Vice-President Frederick J. Gubelman and Chief Engineer George B. Frey, of the O'Rourke Engineering and Construction Company; Henry Japp, managing director of S. Pearson & Son, Incorporated; H. B. Reed, engineer for Contractor J. B. McDonald; St. John Clarke, representing William Barclay Parsons; President D. L. Hough, Vice-President William H. Schmidt and Treasurer J. L. Pruyn, of the United Engineering and Construction Company; J. R. McKee, manager of the mining department of the General Electric Company; E. E. Farrell, contractor; Benjamin B. Lawrence, mining engineer; E. E. Kerwin, division superintendent of the New Jersey Central Railroad; Maurice Bouvier, secretary, W. R. Grace & Company.

The Ingersoll-Sergeant Drill Company was represented by President W. L. Saunders, Vice-President J. P. Grace and Sales Manager J. H. Jowett.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

COMPANY FORMED TO OPERATE A TRAMWAY IN MADRID—The Societe Generale des Tramways de Madrid et d'Espagne has been granted a concession allowing it to build and operate an electric tramway system in Madrid, Spain.

NEW CABLE TO THE FAR EAST—The Postal Telegraph-Cable Company, in connection with the Commercial Pacific Cable, has laid new cables to the Caroline Islands and the Dutch East Indies. These cables are now open for public use.

SOUTHERN BELL TELEPHONE COMPANY TO EXTEND SERVICE—The Southern Bell Telephone and Telegraph Company, of Virginia, has secured an amendment to its charter, increasing the capital stock from $200,000 to $2,500,000. The company proposes in the near future to extend its telephone lines to every county in Virginia.

CONSOLIDATION OF ELECTRIC ROADS IN IOWA—The Mason City & Clear Lake Electric Railway, and the Waterloo, Cedar Falls & Northern Railway are to be consolidated. Extensions to the two roads from Mason City to Waverly, and from Sumner to West Union, comprising 200 miles of track, are contemplated. W. C. Brice is president of the Mason City & Clear Lake Railway, and L. S. Cass is president of the Waterloo, Cedar Falls & Northern.

EXTENSION OF WATER-POWER PLANTS IN SCOTLAND—The Loch Lever Water and Electric Power Company, Scotland, will make an extension to the Fowers water power, which was completed last December. Thomas Meik & Sons have prepared plans and specifications for the scheme, and as soon as these have been approved, bids will be invited for the carrying out of the project. The expenditure will amount to about $2,500,000. All the power at present generated is utilized by the British Aluminum Company.

NEW INTERURBAN ROAD IN MASSACHUSETTS—Plans are now being prepared for the construction of a trolley line from Fitchburg to Boston. The line is to be double-tracked from Ayer to Cambridge, a distance of twenty-seven and three-quarters miles, and will run mainly over private right of way. The time from Ayer to Boston will be one and one-quarter hours. The route will pass through Ayer, Littleton, Acton, Concord, Lincoln, Lexington and Belmont. The capitalists behind the scheme are the owners of the Fitchburg & Leominster and the Leominster, Shirley & Ayer systems, which have just been consolidated.

ELECTRICAL NOTES FROM MEXICO—The Mexican Power Development Syndicate, Limited, has been organized in London with a capital of £5,000. Its object is to construct and operate, in Mexico, electric, steam and other railways and tramways, and electric storage, power and lighting systems. M. C. Miller is forming a company with a capital stock of $10,000,000, for the purpose of building and operating a road in Guadalajara. The road will run from Guadalajara to the port of Chamela, on the Pacific coast. Application has been made to the government of the state of Jalisco for a concession to build the road. The hydroelectric plant which is being erected at Tequisquiakam, near Queretaro, for the purpose of furnishing light and power in the state, will be completed about the middle of September. The company, which is constructing the plant, is capitalized at $500,000.

ELECTRIC RAILROAD PROJECTED IN CUBA—The Havana Central Railroad Company has been incorporated under the laws of the state of New Jersey, with a capital of $5,000,000. The company proposes to build and operate a network of electric lines radiating from Havana. The total mileage planned at present is about 120 miles of single track. The company will require about 15,000 tons of standard-section steel rails. The material for the system, including the machinery for the establishment of car shops near Havana, will be largely purchased in the United States. Twelve thirty-three-ton electric locomotives will comprise part of the equipment. Construction work is to be commenced within one year, and the road, when completed, will carry both freight and passengers. C. W. Van Voorhis is secretary and treasurer of the company, with offices at 52 Broadway, New York city. He is also secretary and treasurer of the Havana Electric Railway Company, with which the new line will have a working agreement. The cost of construction and equipment will amount to about $10,000,000.

FURTHER REDUCTION IN NEW YORK CITY TELEPHONE RATES—The New York Telephone Company has made a further reduction in its rates to large users of the telephone. The reduction amounts to from twenty to fifty per cent. For connecting circuits off the premises to private branch exchanges, or for lines connecting one private exchange with another, the charge has been reduced from $60 and $84 to $48 and $60. Circuits which cross the North river, which are used to connect extension stations with a private branch exchange, or for tie lines, and which formerly cost from $204 to $300, will now cost from $180 to $240 a circuit. Local messages from private branch exchanges in excess of 3,600 messages yearly will be charged for at four cents apiece; or, when contracted for in lots of 400, will cost $3 per hundred. The cost of an auxiliary line and station has been reduced from $48 to $36 per year. The charge for a private exchange with two lines to the central station, with 3,600 yearly local messages, has been reduced from $240 to $216. The cost of additional lines to the central office has been reduced from $36 to $24.

NEW PUBLICATIONS.

THE WHY AND HOW OF INTERURBAN RAILWAYS—This is the title of a pamphlet by Mr. Guy Morrison Walker. In it he discusses the benefits of the interurban railway, both to the users and to the owners of real estate, and shows the relation of the growth of wealth of a community to the growth of railroad lines serving it. The condition of the West before the building of railroads is also discussed.

ANNUAL REPORT OF THE COMMISSIONER OF EDUCATION—The annual report of the commissioner of education, Department of the Interior, Washington, D. C., for the year 1903 has been received. This contains a large amount of information on the various topics related to instructional work. Chapter xix is of particular interest to those giving instruction in engineering, as this consists of a report by Professor Calvin M. Woodward, of Washington University, St. Louis, Mo., on "Manual, Industrial and Technical Education in the United States."

NOTES ON STEAM GENERATION WITH IOWA COAL—The engineering experiment station of the Iowa State College, Ames, Iowa, has issued bulletin No. 9, entitled "Notes on Steam Generation with Iowa Coal," by G. W. Bissell. The pamphlet gives the chemical and physical properties of a number of Iowa coals, together with their heating values, and also the results of a number of tests made to determine the cost of generating steam with different kinds of fuel. The difficulties of burning Iowa coals are discussed, and remedies for some of the troubles are given.

AN INVESTIGATION OF ROTATIONS PRODUCED BY A CURRENT FROM A SINGLE-PHASE ALTERNATOR—This is the title of a thesis submitted to the University of Wisconsin by Mr. Arthur Curtis Scott, for the degree of Doctor of Philosophy. It is published as bulletin No. 102 of the university. The book includes a correlation of experimental data, facts and theories concerning the rise and development of single-phase rotations, and the experimental verification of the fundamental principles which have been evolved, together with a study of related subjects. The possibility of broadening the field of study of the subject, or extending its practical possibilities, was kept in view throughout the work.

ELECTRIC RAILWAYS.

AUSTIN, TEX.—An electric road is to be built from Dublin, in Erath County, to Hamilton, in Hamilton County.

JAMESTOWN, PA.—The Chautauqua Traction Company will extend its line from Mayville to Westfield and Barcelona on Lake Erie. The work will begin at once.

CORRY, PA.—Governor Pennypacker has granted a charter to C. P. Northrup for building the Corry & Findley Lake trolley line. This road will be twenty miles long and will cost $150,000.

CARROLLTON, KY.—The Shelbyville & Ohio River Electric Railway Company will build an electric railway from Shelbyville to Carrollton, a distance of forty-two miles.

ROCHESTER, N. Y.—E. W. Clark & Company, of New York, acting for the Rochester Railway and Light Company, have bought the Rochester & Suburban Railroad for $675,000.

GOWANDA, N. Y.—Plans are being formed to build an electric road from Gowanda to the shore of lake Erie, near Angola. B. F. Parsons, a Brooklyn capitalist, is the chief promoter.

VALLEJO, CAL.—A franchise to operate an electric railroad in Benicia has been granted to F. A. Brandt. The line may be extended to Vallejo and Suisun. Four months are given in which to start operations.

PITTSBURG, KAN.—The Pittsburg electric railway system has been sold by J. J. Taylor to Guy M. Walker, of New York, and Fred H. Fitch, of Chicago. It is the intention to improve the present system and extend it.

WHEELING, W. VA.—The Wheeling Traction Company will extend its line this summer from Martin's Ferry to Brilliant, Ohio, where connection will be made with the Steubenville, Mingo & Ohio Valley road.

PITTSBURG, PA.—The traction line operated between Derry and Latrobe by the Westmoreland Railway Company will probably be extended from Latrobe to Greensburg, westward, and from Derry to Blairsville, eastward.

KENDALLVILLE, IND.—The Toledo & Western Electric Company, which operates a road between Toledo and Fayette, Ohio, will extend the road west to Butler, Ind., Waterloo, Auburn, Ft. Wayne and Kendallville.

KANSAS CITY, KAN.—The Trust Company of America, New York, has advanced $2,000,000 for the construction of the Bonner Springs and Topeka roads. This money is to be secured by a mortgage on the property of the electric line.

LA CROSSE, WIS.—A survey is being made by the La Crosse & Onalaska City Railway Company for the extension of its electric line from Onalaska to Holmen, Wis. It is proposed to eventually extend the line to Galesville, Wis.

EAST HAMPTON, CT.—Ransom & Hoadley, of Providence, R. I., are making a set of surveys for a trolley line from East Hampton to Moodus. The projected line is about ten miles long, and the road can be constructed, it is estimated, for about $175,000.

MAHANOY CITY, PA.—A Schuylkill County syndicate, headed by Assistant United States Treasurer W. S. Leib, and Dr. J. C. Biddle, has purchased the Schuylkill Traction and Lakeside railway lines, operating between Mahanoy City, Ashland and Shenandoah.

WILMINGTON, DEL.—The Odessa & Middletown Electric Railway Company has decided to extend its line nine miles to Delaware City. When this extension is completed there will be a line of electric railway from Wilmington to Middletown, a distance of twenty-five miles.

PROVIDENCE, R. I.—The Providence & Burrville Street Railway Company is to build twenty miles of double-track railway between Providence, Pawtucket and Woonsocket. A mortgage of $750,000 has been issued to the Rhode Island Hospital Trust Company to secure funds for the work.

CHICAGO, ILL.—The Chicago & Southern Traction Company has secured a tract of land in Riverside, on which to erect a power plant. There will be five structures, consisting of powerhouse, car barn, repair shop, substation and equipment building. The preliminary cost is estimated at $100,000.

LIVE OAK, FLA.—The Suwannee Springs Railway Company has been granted a franchise to build and operate an electric line in Live Oak, and also to build a line to Suwannee Springs, a distance of seven miles. The principal stockholders of the road are C. J. McGehee, F. L. Rees and B. W. Helvenston.

ORILLIA, ONTARIO—The Orillia town council and the James Bay Railway Company have reached an agreement, by which the latter undertakes to run its main line between Toronto and Sudbury, through Orillia, in return for a bonus of $30,000 and a right of way over the town's property, where the line touches it.

WILMINGTON, DEL.—The West Chester Street Railway Company will install a freight service on its trolley line to Kennett Square, Gallagherville and other points. A traffic arrangement may be made with the West Chester, Kennett & Wilmington Company, which operates a line between Wilmington and Kennett Square.

LAPORTE, IND.—Judge A. B. Anderson, of the federal court, has ordered that the Chicago & South Shore Railway Company's interurban line between Laporte and Michigan City, including all property rights and franchises, be sold at receiver's sale at the court house in the city of Laporte on Friday, May 26. The system is estimated worth nearly $500,000.

ROME, N. Y.—The Rome & Oneida Electric Railway Company has been formed to build an electric road from Rome to Oneida. The capital is $150,000. The following managing directors were elected at a recent meeting: DeWitt C. Hadcock, L. Mittenmaier, M. J. Larkin, A. R. Kessinger, William Soper, Charles Bernstein, George Maycock, John Hadcock and J. H. Bailey.

BELLEFONTE, PA.—A charter was granted some time ago to the Bellefonte Traction Company to construct a road from Bellefonte to State College, taking in Milesburg, Coleville, Axeman, Pleasant Gap and Lamont. The company has secured the street rights in all the above boroughs, as well as the right of way through the townships. The road will be about twenty miles long, with an average cost of $20,000 per mile for construction and equipment.

ROCK ISLAND, ILL.—The stockholders of the Rock River Traction Company held their annual meeting recently in Prophetstown. The following officers were elected: president, Levi Waterman, Geneseo; vice-president, F. E. Andrews, Sterling; secretary, Hugh W. Cole, Geneseo; treasurer, William McNeill, Prophetstown. The stockholders voted to instruct the directors to increase the capital stock of the company from $200,000 to $1,500,000, and also to issue bonds to the same amount.

JOLIET, ILL.—A license has been granted to the Chicago, Bloomington & Decatur Railway Company. It is proposed to construct the road from Chicago, through Joliet, Morris, Pontiac, Bloomington and Clinton, to Decatur. The incorporators and first board of directors are: William B. McKinley, D. R. Stephens, Charles Zilly, H. J. Pepper and S. A. Power, all of Champaign. The same parties have formed the Champaign Traction Company, which will take in the towns of Pekin, Bloomington, Clinton, Monticello, Champaign and others. Considerable work has been done on the Aurora, DeKalb & Rockford Railway, and it is expected that the line will be finished between Aurora and DeKalb by July.

TELEPHONE AND TELEGRAPH.

XENIA, OHIO—The Bell Telephone Company will build underground conduits.

PORTLAND, ORE.—A telephone line is to be built between Days Creek and Canyonville.

BUFFALO, N. Y.—The Consolidated Telephone Company has extended its lines to Glenside.

SHERBURNE, N. Y.—The Earlville Telephone Company will install an exchange in Sherburne.

CLARENCE, IOWA—The Clarence Telephone Company will erect an office and exchange building.

SOUTH BYRON, N. Y.—The Byron Telephone Company has installed a new switchboard in its exchange.

PHILIPSVILLE, PA.—A new telephone line is being built from

Owen's Corners to Philipsville, where it will join the independent system.

PETERSBURG, VA.—The Petersburg Telephone Company has purchased a site for a new exchange building.

SUMAS, WASH.—The Sumas town council has granted a franchise to the Farmers' Mutual Telephone Company.

FOSTORIA, OHIO—The Postal Telegraph-Cable Company is rebuilding its lines between Belmore and Cleveland.

WEST ALEXANDER, VA.—The Claysville Telephone Company is planning to establish an exchange at West Alexander.

ALBANY, GA.—Owing to increasing business the Southern Bell Telephone Company's exchange at Albany will be enlarged.

YOUNGSTOWN, OHIO—The Bell Telephone Company has purchased the franchise which was secured last fall by Homer Hood.

GOLDFIELD, NEV.—D. H. Peery is forming a telephone and telegraph company to operate from Las Vegas, Nev., to Rhyolite and Goldfield.

ASHLAND, KAN.—A telephone line will be built from Ashland to the county line, where it will be connected with the Meade County system.

ALLENTOWN, PA.—The Interstate Telephone and Telegraph Company, of Pennsylvania, will erect a telephone line to Coopersburg during the summer.

TREMONT, ILL.—A force of men is at work building a new telephone line from Tremont to Peoria, to connect with the Interstate long-distance company.

GLESSNER, PA.—A company has been organized to run a telephone line from Boswell to Jerome, and connect with quite a number of farms between the two places.

TRENTON, N. J.—The common council of New Brunswick has granted an extension of a year to the New Jersey Telephone Company in which to complete its system in that city.

HALIFAX, NOVA SCOTIA—The Canadian government has decided to install wireless telegraph equipment on Sable Island and on Chebuco Head, at the entrance of Halifax harbor.

BATAVIA, N. Y.—There has been filed in the county clerk's office a certificate showing that the capital stock of the Darien Telephone Company has been increased from $800 to $5,000.

DESPATCH, N. Y.—The Bell Telephone Company is now constructing a new line from Penfield village north along the Five-Mile line to Kennedy's Corners, then west to the Sperry Mills.

DECATUR, ILL.—H. H. Randolph has sold to the Bell corporation two of the toll lines that he constructed in 1902. These lines run form Maroa to Lincoln. The consideration is given as $12,000.

WAITSBURG, WASH.—An ordinance granting a twenty-five-year franchise to the Waitsburg Rural Telephone Company to erect poles and string wires in the streets and alleys has been passed.

BALTIMORE, MD.—The Hotel Rennert Company has made arrangements with the Chesapeake & Potomac Telephone Company for the installation of a private branch exchange of over 300 stations.

JOANNA, PA.—The Conestoga Telephone Company will extend its line from Amityville to Wyncote, to connect with the United company, thereby securing communication with Pottstown and vicinity.

BALTIMORE, MD.—The Union Telephone Company, of Trump, of which Charles L. Almony is president and S. S. Van Trump, manager, has increased its capital from $3,000 to $10,000, and will extend its line.

SANDUSKY, OHIO—To take care of increasing the business the Central Union Telephone Company is arranging for additions and improvements to its local plant. A new 100-drop switchboard will be added, and a new cable is also to be installed.

PARSONS, TENN.—A new telephone exchange has been put in at Parsons. The principal stockholders are W. C. Cole, Perryville; Walter Sloan, Linden, and the Beech River Phosphate Company. The lines will cover Perry, Wayne and Decatur counties.

CINCINNATI, OHIO—The Cincinnati & Suburban Bell Telephone Company has made application to the board of public service for a permit to lay subway conduits on the hill tops, in which to place its wires. The work will cost from $85,000 to $100,000.

PHOENIX, ARIZ.—It is announced that the Sunset Telephone, Telegraph and Electric Company has bought the property and franchise of the Gila Valley telephone system, including 300 miles of wire running from Roosevelt, through the Gila valley, to Clifton.

WATERLOO, IOWA—The property, franchise and all appurtenances of the United States Telegraph and Telephone Company, with exchanges in fourteen counties in northwestern Iowa, have been sold to Thomas Caskaden, of Waterloo, for $55,000, at public sale.

DOYLESTOWN, PA.—The Warrington Mutual Telephone Company has made arrangements to extend its line from Warrington to North Wales, *via* Chalfont. This will give the company an outlet through the Keystone company, where connection can be made for long-distance calls.

BLOSERVILLE, PA.—The Bloserville Telephone Company has elected these officers: president, J. S. Darr; vice-president, C. H. Leib; secretary, A. H. Calaman; treasurer, H. E. Buckwalter. Work on the line will soon be commenced. Denton Huntsberger, of Newville, will do the construction work.

SAGOLA, MINN.—The Sagola Telephone Company has decided to extend its line from Sagola, Dickinson County, north to the neighboring town of Channing. Connection also will be made with the Michigan long-distance lines at Iron Mountain, to the south, following the Milwaukee roads right of way.

ROCHESTER, N. Y.—The Independent Union Telephone Company has given to the Knickerbocker Trust Company a mortgage for $500,000. The purpose of the Independent Union company is to acquire, build, maintain and operate telephone lines and exchanges in Erie, Niagara, Chautauqua and Orleans counties.

TROY, N. Y.—D. A. Reynolds, vice-president and manager of the State Line Telephone Company, has organized an independent company at Peekskill. The new company will have its line in operation by July 1, and will reduce the price of telephones to eighteen dollars per year. There will be special fire and police calls.

WHEELING, W. VA.—The National Telephone Company will soon be connected with the West Virginia Western Telephone Company, which operates about Parkersburg and Marietta. The latter company is building its line northward to meet the National, and already has the line completed to some distance above Newport, leaving an intervening gap of less than twenty miles.

HONEOYE FALLS, N. Y.—At a meeting of the village board of trustees of Honeoye Falls, the right was granted to the Inter-Ocean Telegraph and Telephone Company to erect, maintain and operate a telephone system in Honeoye Falls. The company now has connection with the Home, Blake and Mendon Center lines coming into Honeoye Falls, and desires to have Lima, Rush and Mendon and nearby towns connected.

DENVER, COL.—The Colorado Telephone Company has issued its report for 1904. The gross earnings of the company in 1904 amounted to $1,497,350, compared with $1,294,838 in 1903. The expenses in 1904 were $1,118,196, compared with $977,734 for 1903. This gives the net earnings for 1904 as $379,154, compared with $317,104 for 1903. The capital stock of the company December 31, 1904, was $4,354,150, an increase of $200,600, and the number of subscribers was 37,102, an increase of 6,876 over 1903.

DETROIT, MICH.—Between $15,000 and $16,000 will be spent in the next ninety days for the improvement of independent telephone toll line service between Detroit and Lansing; Detroit, Ann Arbor and Jackson; Detroit and Northville, and Detroit and Holly. New double copper circuits will be installed, and in all 480 miles

of copper wire strung. The work between Detroit and Lansing will be done by the Peninsular Telephone Company, Detroit; Livingston County Telephone Company, Howell, and the Citizens' Telephone Company, Lansing; between Detroit, Ann Arbor and Jackson, Peninsular Telephone Company, and the Washtenaw County Telephone Company, Ann Arbor; between Detroit and Northville the Peninsular Telephone Company; between Detroit and Holly the Peninsular Telephone Company.

PERSONAL MENTION.

MR. FRANCK Z. MAGUIRE, of London, England, has established a New York office in the Astor Building, 10 Wall street. Mr. Maguire represents a number of electrical interests abroad.

MR. JAMES H. FAGAN on May 1 resigned his position as manager of the Herkimer exchange of the County Telephone Company, of Herkimer, N. Y. Mr. Fagan had been connected with the company for about four years.

MR. JAMES W. SCOTT, of St. Louis, Mo., has been elected treasurer of the San Marcas Valley Interurban Railway Company, which will build an electric line in Texas from San Marcas to Luling, a distance of fifteen miles.

MR. CHESTER I. CAMPBELL, manager of the International Electrical Exhibition, Boston, Mass., which will be held in July, is visiting electrical people in New York, Philadelphia, Baltimore and Pittsburg, interesting them in this project.

MR. WILLIAM G. MATHER, Cleveland, Ohio, who delivered the class day address at the Michigan College of Mines, Houghton, Mich., on May 5, is one of the best known iron-mining men in the country. His address was of exceptional interest.

MR. W. G. SCHRON, late of the Westinghouse Machine Company, has entered the service of the Allis-Chalmers Company, making his headquarters at the Pittsburg office. He will devote his attention to the sale of gas engines, steam engines and steam turbines.

MR. ARTHUR E. JACKMAN, for some time manager of the Willimantic (Ct.) Gas and Electric Light Company, will locate in Boston, Mass., as manager for the Adams-Bagnall Company, of Cleveland, Ohio. His offices will be in the Boston *Journal* Building.

MR. H. M. WHARTON, engineer of works for the Westinghouse Electric and Manufacturing Company for the past five years, has resigned his position. He will become one of the chief designing engineers for the Allis-Chalmers Company, Milwaukee, Wis.

MR. JACQUES M. BRAMLETTE has resigned his position as general superintendent of the East St. Louis & Suburban Railway system. He will take the position of general manager of the Philadelphia & Western Interurban Railway Company, which is building a road from Philadelphia to Lancaster.

MR. WILLIAM C. HUBBARD, for several years with the Westinghouse Electric and Manufacturing Company, severed his connection on May 1, and has entered the sales department of the Cooper Hewitt Electric Company, New York city. Mr. Hubbard has had considerable experience in the lighting field, having been associated with Professor L. B. Marks in the development and introduction of the first commercial enclosed arc lamp in this country. For two years he was vice-president and general manager of the Electric Arc Light Company, and afterward New York manager of the Manhattan General Construction Company, until both companies were absorbed by the Westinghouse interests.

MR. A. P. HEAD, the London representative of the Wellman-Seaver-Morgan Company, has recently completed a tour around the world and has established the following subagencies for the company: Melbourne, Australian Metal Company as Australian agents. The branches of this concern are as follows: New Zealand, the Gilbert Machinery Company, Wellington; Queensland, James Stothert, Brisbane; North Queensland, James Croker, Mackay; New South Wales, W. R. Laidley, Sydney; South Australia, James C. Fraser, Adelaide; West Australia, A. E. Thomas, Koolgardie; Tasmania, Lindsay Tullock, Launceton. In India the following agents representing the presidencies of Bombay, Bengal and Madras, have been appointed: J. Harper, Calcutta; Frank Harrison, Bombay; W. H. Oakes, Madras.

MR. ALBERT S. CRANE has been secured as chief hydraulic engineer for J. G. White & Company, Incorporated, New York city. Mr. Crane was born in 1867, and was graduated from Cornell University in 1891. Since graduation he has been actively engaged in hydraulic work. Mr. Crane designed the details of the Fortress Monroe sewage system for the United States engineer's office, and from 1895 to 1898 was assistant engineer of the Department of City Works, of Brooklyn. From 1898 to 1901 Mr. Crane was engaged on the development of the Michigan & Lake Superior Power Company at Sault Ste. Marie, as chief assistant engineer, and was chief engineer of the Lake Superior Power Company, at the same place, until 1902. Since 1902 Mr. Crane has been engaged as principal assistant engineer of the Sanitary District of Chicago. He has also been engineer for a number of other hydraulic installations. As chief hydraulic engineer for J. G. White & Company, he will be in responsible charge of the hydraulic department.

OBITUARY NOTICES.

MR. WELLS DYGERT, Buffalo, N. Y., died at his home in that city on April 27, after a brief illness. Mr. Dygert was sixty years of age, and was the proprietor of the Buffalo Electric Company.

MR. HENRY P. FLYNN, Carthage, N. Y., died on April 27 after an illness of several months. He was director of the Northwestern Telephone Company, the Carthage National Bank, and the West End Paper Company.

ELECTRICAL SECURITIES.

There was but little change in the character of the stock market last week. In the early sessions prices rallied somewhat, falling later in the week to still lower levels. However, a new element was injected into the situation in the form of increased support from outside investors. Many believe that the issues which were shied at a month ago because of fancy prices are now more or less in the form of bargains, and there is, consequently, some eagerness to buy. This support is not sufficient to influence any immediate change in the situation, unless it becomes a part of the movement instituted by powerful professional interests. These interests, however, appear to be satisfied to let things stand as they are for the present.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MAY 6.

New York:	*Closing.*
Brooklyn Rapid Transit	60⅜
Consolidated Gas	198½
General Electric	173
Interborough Rapid Transit	203
Kings County Electric	200
Manhattan Elevated	164¾
Metropolitan Street Railway	116⅝
New York & New Jersey Telephone	171½
Westinghouse Manufacturing Company	192

Boston:	*Closing.*
American Telephone and Telegraph	141¾
Edison Electric Illuminating	250
Massachusetts Electric	86½
New England Telephone	138½
Western Telephone and Telegraph preferred	99

Philadelphia:	*Closing.*
Electric Company of America	12⅛
Electric Storage Battery common	78
Electric Storage Battery preferred	78
Philadelphia Electric	11¾
Philadelphia Rapid Transit	32¼
United Gas Improvement	114½

Chicago:	*Closing.*
Chicago Telephone	142
Chicago Edison Light	161
Metropolitan Elevated preferred	60
National Carbon common	59
National Carbon preferred	114¾
Union Traction common	8
Union Traction preferred	37

South Side Elevated for April carried a daily average of 91,901 passengers, an increase of 401.

NEW INCORPORATIONS.

URBANA, OHIO—Urbana Light Company. $100,000.

LAMONI, IOWA—Lamoni Telephone Company. $25,000.

ST. PAUL, MINN.—The Watkins Telephone Company. $10,000.

LINCOLN, NEB.—Greeley County Telephone Company. Increased to $50,000.

BIRMINGHAM, ALA.—The Brighton Waterworks and Power Company. $10,000.

CLEVELAND, OHIO—People's Electric Lighting and Power Company. $10,000.

MANNING, IOWA—Hawkeye Electric Company. $50,000. Incorporators: A. K. Resner and others.

MOULTON, IOWA—Farmers' Mutual Telephone System. $1,000. Incorporators: S. H. Jordan and others.

BUFFALO CENTER, IOWA—Buffalo Township Telephone Company. $6,000. Incorporators: O. B. Russ and others.

HUBBELL, NEB.—Frontier Telephone Company. $8,000. Incorporators: Frank Emmery Bell, M. G. Bell and L. F. Heuer.

EAST ST. LOUIS, ILL.—St. Clair Light and Power Company. $7,500. Incorporators: H. C. Barnard, C. L. Gray and R. W. Sikking.

MIAMI, FLA.—Florida Power Company. $300,000. Incorporators: W. N. Camp, Clarence Camp, O. T. Green, R. F. Brewer and G. D. Munsing.

NEWARK, N. J.—The American Beck Electric Lighting Company. $125,000. Incorporators: Eli Teeter, Thomas J. Butler and Theodore D. Gottlieb.

NEWTON, N. J.—Branchville Electric Power, Water and Lighting Company. $30,000. Incorporators: Charles H. Crisman, S. S. Wills and E. T. Wills.

EAST GRAND FORKS, MINN.—Banner Telephone Company. $25,000. Incorporators: Arney Grundysen, O. Osmunden, P. J. McCoy and B. Johnson.

NEWARK, N. J.—The New Jersey Beck Electric Lighting Company. $125,000. Incorporators: Charles A. Woodruff, Thomas J. Butler and Eli Teeter.

DOVER, ME.—Eastern Electric Company. To generate gas and electricity. $10,000. President, W. C. Woodbury, treasurer, F. E. Guernsey, both of Dover.

CONNERSVILLE, IND.—Connersville Railway Company. $100,000. Incorporators: J. E. Jeffries, W. E. Rowe, G. C. Florea, L. O. Burgess and R. Neil Burgess.

BOLIVAR, N. Y.—The Van Dermark Telephone Company. To construct a line from Van Dermark Creek to Scio, there to connect with the Inter-Ocean company's line. $1,200.

ST. LOUIS, MO.—Marissa Farmers and Merchants' Telephone Company, of Belleville. $10,000. Incorporators: C. W. Nevin, S. S. Boyle, W. H. Meek and J. A. Hamilton.

RALEIGH, N. C.—Oxford Water and Electric Company. $50,000. Incorporators: Harry L. Millner, Morganstown; W. T. Sherman and W. E. Richardson, of Washington, D. C.

GUTHRIE, OKLA.—Driftwood Telephone Company. $10,000. Officers: John Nelson, president; William Lightburn, secretary, both of Capron; L. C. Strothers, treasurer, of Kiowa.

NEW YORK, N. Y.—The Municipal Subway Company. To install conduits for electrical conductors. $100,000. Incorporators: J. Bears, W. J. Boroughs and George Stewart, New York city.

MAGNET, NEB.—The Magnet Independent Telephone Company. $10,000. Incorporators: A. J. Williams, P. J. Spaulding, A. N. Swanson, E. E. Snygg, Victor Johnson, Fred Clausen and I. O. Woolsten.

ALBANY, N. Y.—Bellport Lighting Company, of Bellport. $10,000. Directors: Edmund F. Hawkins, Isaac H. Cleaves, George Carman, Alfred S. Osborne, Everett M. Price, William F. Gardner and Henry E. Corwin, of Bellport.

PORTLAND, ME.—The Sumpter & Northwestern Railway Company. To construct and operate a line of steam and electric railway, together with a telephone and telegraph line. $500,000. President, H. E. Mason.

MILWAUKEE, WIS.—Badger Telephone Company, of Oconomowoc. To construct lines in Waukesha, Dodge and Washington counties. $2,000. Incorporators: Thomas Steele, J. J. Reid and Harry Rosenow, of Oconomowoc.

GUTHRIE, OKLA.—The Spring Creek Telephone Company. To operate in Kiowa, Washita and Caddo counties. $2,000. Incorporators: A. J. McMillan, W. T. Parnell, H. A. Lamherson, T. E. Givens, J. W. Gray and A. F. Kobs.

WILMINGTON, DEL.—Consumers' Light, Heat and Power Company, of Chicago; $1,000,000; incorporators: William M. Flook, of Chicago, and James H. Hughes and James L. Wolcott, of Dover. Citizens' Light, Heat and Power Company, of Chicago; $300,000.

WAKITA, OKLA.—Citizens' Telephone Company. $5,000. Incorporators: J. S. Burchfield, president; S. A. Lively, vice-president; G. W. Guthrie, secretary; Ernest Lemon, treasurer; F. P. Singer, J. W. Francis and R. H. Allen, directors, all of Wakita.

LORAIN, OHIO—Lorain & Eastern Traction Company. To construct a short line from the Lake Shore Electric line at Beach Park to South Lorain. $10,000. Incorporators: T. H. Hogsett, H. H. Johnson, George H. Kelly, George Cook and M. G. McAleenan.

RICHMOND, VA.—Kinston, Brighton & Northern Railroad Company, of Northampton County, Va. To construct steam, electric and other railroads. $100,000. Officers: W. E. Dickinson, president, New York; W. G. Smith, vice-president, and G. B. Morton, secretary, Cape Charles, Va.

LOUISVILLE, KY.—The Carrollton & Northville Railroad Company. To construct an electric road nine miles long between the towns named. $50,000. Incorporators: H. E. Randall, of Evansville; A. Z. Boyer, Theodore Snively, Charles E. Davis, John C. J. Watson, H. B. Moore and G. D. Crain, of Louisville.

RICHMOND, VA.—Bedford & Campbell County Telephone and Telegraph Company, of Coffee, Bedford County. To construct and operate a telephone line from Coffee, Va., to Lynchburg, Va., and adjacent points. $5,000. Incorporators: F. W. Nelson, president, Forest, Va.; B. D. Clay, secretary and treasurer, Coffee, Va.

INDIANAPOLIS, IND.—The Fort Wayne, Marion & Bluffton Traction Company. To build an electric road connecting Fort Wayne, Sheldon, Bluffton, Warren, Marion, Van Buren, Curryville, Decatur and Monroeville. $550,000. Directors: Frank H. Cutthall, Samuel L. Morris, Harry E. Vordermark, Fred C. Baase and F. H. Schmidt.

LITTLE ROCK, ARK.—Merchants' Investment Company, of Little Rock. To promote, construct, own and operate electric light and power plants for the production, generation and furnishing of power and light. $250,000. Officers: C. J. Kramer, president; William S. Michell, vice-president; J. B. Wishendorff, secretary; Harry Lasker, treasurer.

TROY, N. Y.—Lewis & Elizabethtown Telephone Company. To operate lines from Elizabethtown through Lewis, Chesterfield, Jay, Elba, Keene, Westport, Willboro and Essex. $4,000. Directors: A. J. Durand, A. E. Coonrad, of Elizabethtown; F. A. Marvin and S. S. Beardsley, of Lewis; E. M. West, of Reber; J. S. Laverty, of New Russia, and W. H. Lobdell, of Wadham's Mills.

ALBANY, N. Y.—Danby Telephone Company. To build telephone lines from Ithaca to Danby, South Danby, Spencer and Candor, and through the towns of Danby, Ithaca, Newfield and Caroline. $7,500. Directors: J. E. Black, Charles E. Bruce, C. F. Denman, F. D. Gunderman, T. W. Slocum, of Danby; H. F. Hutchings, of West Danby, and P. T. S. Ward, of South Danby.

AUGUSTA, ME.—Portland & Lewiston Railway Company. To build an electric line thirty-two miles in length from Morrill's Corner, in Portland, through West Falmouth, West Cumberland, Gray, North Gray, New Gloucester and Upper Gloucester, to Auburn. $130,000. Directors: Edward W. Cross, Auburn; John W. True, New Gloucester; Lewis A. Goudy, L. M. Leighton, Thomas M. Johnson and Jabez True, of Portland, and Frank Redlan, Boston.

ELECTRIC LIGHTING.

JOPLIN, MO.—The board of public works is preparing to spend $30,000 on the city's electric light plant.

BENNINGTON, VT.—The Bennington Electric Company has taken over the Bennington Water and Light Company.

FORT MADISON, IOWA—The Fort Madison city council has voted to install thirty-six additional arc lamps for street lighting.

BELLINGHAM, WASH.—The city council will establish an electric light plant in connection with the pumping plant on Sehome Hill.

BELLEFONTAINE, OHIO—Bellefontaine has voted in favor of issuing $50,000 bonds for improving the municipal electric light plant.

WATKINS, N. Y.—The property of the Watkins Gas and Electric Light Company has been sold to M. L. Dreisbach, of Easton, Pa., for $7,500.

EDWARDSVILLE, ILL.—The Pana electric light plant has been sold to A. H. Bickmore & Company, the representatives of a New York syndicate.

CASTLE ROCK, ORE.—A franchise has been granted to the Kalama Light and Power Company allowing it to furnish electric light and power.

HARRINGTON, WASH.—William Brodie and James Shaw, of Ritzville, have applied for an electric light franchise. The plant will cost $20,000.

NYACK, N. Y.—A franchise has been granted the Rockland & Orange County Electric Company, of Monroe, to establish a line in the town of Chester.

WOODSTOCK, VA.—The town of Newmarket has granted a franchise for an electric light system. It is expected that the plant will be in operation by June 1.

MUNCIE, IND.—The Citizens' Electric Light Company has purchased a site for a power plant. The site is on South Walnut street, adjoining the Big Four tracks.

NATCHEZ, MISS.—The towns of New Albany and Ellisville are to build electric light plants and waterworks. W. J. Wilcox is in charge of the work at both places.

SUMAS, WASH.—Franchises have been granted to the Sumas Electric Light, Water and Power Company. Work upon the plant is to commence within sixty days, and it will cost $20,000.

LAUREL, MISS.—The Laurel Improvement Company has been granted a franchise by the city of Laurel for a light and power station. It will begin at once the erection of a $25,000 plant.

READING, PA.—Judge Hassler, at Lancaster, has awarded control of the Lancaster Electric Light, Heat and Power Company to a Philadelphia syndicate, headed by Clarence H. Burr, to reorganize the concern.

LEWISTON, IDA.—Francis Jenkins and associates, of Moscow, Ida., are giving attention to plans for the establishment of a large power plant at Elk Creek Falls, where minimum capacity is about 3,500 horse-power.

LA GRANDE, ORE.—The consolidation of Grand Ronde Electric Company and the La Grande Storage Water Company has been announced. The directors are J. A. Thronsen, Walter M. Pierce, W. G. Hunter, T. H. Crawford.

ARTHUR, ILL.—The Charleston Gas and Electric Company has been sold to the Charleston Illuminating Company for a consideration of $240,000. Congressman W. B. McKinley, of Champaign, heads the new company.

CANTON, N. Y.—The electric light company plans to make improvements in its plant to the extent of $10,000. New buildings will be erected, and two 100-horse-power engines and one 120-kilowatt generator will be installed.

MARION, IND.—The Citizens' Heat and Light Company, at a recent directors' meeting, decided to go out of business. An assessment of one per cent will be levied on all stockholders to meet the obligations of the company.

SHENANDOAH, PA.—The directors of the Citizens' Electric Light Company have elected officers as follows: president, William Krick; vice-president, W. H. Waters; secretary, J. W. Daddow; superintendent and treasurer, T. F. Bradigan.

WINNIPEG, MANITOBA—The Emerson-Roseau Power Company has elected officers as follows: president, L. Stuart; vice-president, D. H. McFadden; general manager, George Pocock; secretary, H. H. Logan; treasurer, A. E. Hoskins.

HARTFORD, CT.—The Hartford Electric Light Company is to increase its capital stock from $1,400,000 to $3,000,000, and it will also increase its outstanding bonds to $2,000,000. The company now has out an issue of bonds amounting to $200,000 and maturing in 1915.

BAKER CITY, ORE.—The Baker Light and Power Company has been incorporated with a capital stock of $400,000, by C. A. Johns, F. N. Averill and J. H. Parker. This corporation takes over the Rock Creek Power Company and the Baker City Gas and Electric Company.

SPRINGFIELD, OHIO—The Springfield Light and Power Company, which is owned by the American Railways Company, of Philadelphia, Pa., has been bought by the People's Light, Heat and Power Company, of Springfield, which has been incorporated with a capital of $2,000,000.

OMAHA, NEB.—The city has entered into a four-year agreement with the Omaha Electric Light and Power Company, whereby the latter is to light the city's streets for $75 per light per year. This is a reduction of $19.50 from the present rate. The city is to use at least 600 lights at all times.

IOWA FALLS, IOWA—The Iowa Falls Electric Light and Power Company's heat and light plants have been transferred to the Pearsen Heat, Light and Water Company, a Des Moines corporation. The present officers will be retained. The transfer follows an option given the Des Moines company's agents a short time ago.

POTTSVILLE, PA.—The Frackville & Gilberton Light, Heat and Power Company has elected as directors W. C. Wagner, John Dunlap, Samuel Bailey, Orval Miller, Garrett Keating, Thos. Lafferty, David Taggart, C. A. Bleiler and G. W. Johnson. The officers are: president, David Taggart; secretary, C. A. Bleiler; treasurer, L. C. Anstock.

CLARKSVILLE, TEX.—The Clarksville Light and Power Company has been sold to the Clarksville Light Company, a new concern, composed of D. W. Cheatham, president; B. A. Dinwiddie, vice-president; John W. O'Neill, secretary, and A. M. Graves. The company has also purchased machinery for an ice plant, which it will run in connection with the light plant.

BALTIMORE, MD.—The Mount Washington Electric Light and Power Company has begun the erection of a new power-house on the site of the present one. The power-house will be twice the size of the old one, and will be built of brick and steel. The roof will be of slate. The building will be equipped with the most improved machinery when completed. John A. Sheridan & Company have been awarded the contract for the erection of the building.

NEW MANUFACTURING COMPANIES.

CINCINNATI, OHIO—Articles of incorporation of the John A. Stewart Electric Company have been filed. The company is capitalized at $40,000, and will take over the interests of John A. Stewart and others.

AUSTIN, TEX.—The Kane Company, of Fort Worth, has been incorporated to manufacture steam, gas and electrical fittings. The company has a capital of $50,000, and the incorporators are J. D. Kane, Lee and M. Stephens.

DOVER, DEL.—The National Electric Alarm Company has been organized with a capital of $500,000. The company will purchase, manufacture and sell electrical devices for the protection of bank and other property and private residences.

AUGUSTA, ME.—The O'Brien Electrophone Company has been organized at Augusta for the purpose of manufacturing and dealing in electric and magnetic appliances of all kinds, with a capital of $500,000. I. L. Fairbanks, of Augusta, is president.

INDUSTRIAL ITEMS.

THE COMMERCIAL ELECTRICAL SUPPLY COMPANY, 1907 Market street, St. Louis, Mo., is distributing a net price list on Commercial high-grade incandescent lamps.

THE C & C ELECTRIC COMPANY, New York city, has removed its general office to its factory at Garwood, N. J. It will, however, maintain a branch office at 149 Broadway, New York city.

G. M. GEST, the expert subway contractor of New York and Cincinnati, has been awarded the contract to construct a complete underground conduit system for the Consolidated Electric Light Company of Maine, at Portland, Me.

THE PITTSBURGH TRANSFORMER COMPANY, Pittsburgh, Pa., is calling attention to several letters it has received, in which statements are made regarding the remarkable efficiency of Pittsburgh transformers under severe conditions of service.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio, manufacturer of the "Sterling Special" lamp, is distributing an interesting booklet entitled "The Mystery of the Missing Kilowatts." This may be secured upon application.

THE H. W. JOHNS-MANVILLE COMPANY, New York city, has established new branch offices in San Francisco, Seattle, Kansas City, Los Angeles, Little Rock and Minneapolis. The company now has eighteen branches, covering the entire United States and Europe.

THE CINCINNATI ELECTRICAL TOOL COMPANY, Cincinnati, Ohio, is distributing a new catalogue descriptive of its portable electric drills and electric grinders. Dimensions and illustrations are given of these drills, which may be run from any incandescent lamp circuit.

THE ROLFE ELECTRIC COMPANY, Rochester, N. Y., is distributing a catalogue descriptive of some of its specialties. In addition to this material the book contains the electrical laws and rules of practice, together with a number of valuable tables for electricians and engineers.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is now located in its new headquarters, 134-140 West Jackson Boulevard. The new building which, it states, is the largest warehouse in the world devoted exclusively to electrical supplies, gives added facilities for the prompt handling of its increasing business.

THE NORTH ELECTRIC COMPANY, Cleveland, Ohio, will be pleased to send upon application a new bulletin which it has published, entitled "The Voice of Progress." This bulletin voices forth an appreciation of the rural telephone, detailing the advantages which it has brought to farming communities.

THE CROUSE-HINDS COMPANY, New York city, maker of switchboards, panelboards, knife switches, "Norbitt" specialties and "Hawley" time registers, has removed its offices from the ground floor of the Havemeyer Building, 23 Dey street, to more commodious quarters on the eighth floor, room No. 804, in the same building.

THE CHASE-SHAWMUT COMPANY, Newburyport, Mass., has issued bulletin No. 31, describing the "Shawmut" conduit outlet bushing, which is a capping for the free ends of iron-armored conduit. The bulletin supersedes bulletin No. 26, and contains prices on the larger sizes of bushings, as well as reduced prices of locknuts.

THE LECLANCHE BATTERY COMPANY, 111-117 East One Hundred and Thirty-first street, New York city, is calling attention to the "Gonda" wedge cell. This type of cell is a radical departure from ordinary primary battery construction. The company will be pleased to send a complete description of the cell upon application.

THE WARD LEONARD ELECTRIC COMPANY, Bronxville, N. Y., has issued bulletins Nos. 19038, 19052 and 19053. No. 19038 describes resistance units which are carefully tabulated, showing the resistance and capacities of the various-sized units. No. 19052 describes motor starters, and No. 19053 motor field rheostats and motor speed control.

THE HOLOPHANE GLASS COMPANY, Glackner Building, New York city, is distributing another booklet in its series of illumination literature. This is entitled "The Lighting of Hotels and Clubs." In addition to the text, there are a number of illustrations giving practical demonstrations of the utility of the Holophane globe as a modern aid to illumination.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Ct., will erect a new building 40 by 106 feet, and three stories high. The building will be equipped with machinery for manufacturing electrical appliances. The boiler room will be 36 by 40 feet, and the boiler plant will be of 100 horse-power. The building will give the company 16,000 feet of additional floor space.

THE BAUSCH, LOMB, SAEGMULLER COMPANY, Rochester, N. Y., has been incorporated to manufacture engineering, astronomical, physical and other instruments of precision. The Bausch & Lomb Optical Company is to be the sales agent of the new corporation, whose manufacturing plant is to be in the north end of the recently completed large addition to the Bausch & Lomb factory.

J. H. BUNNELL & COMPANY, INCORPORATED, 20 Park place, New York city, have brought out their catalogue for 1905-1906. This is the twenty-fifth edition, and describes telegraph instruments and appliances, telephone apparatus and fittings, fire-alarm equipment, bells, batteries and general electric supplies. The catalogue is bound in cloth, and has about 400 pages, profusely illustrated.

EUGENE MUNSELL & COMPANY AND THE MICA INSULATOR COMPANY, Chicago, Ill., are sending to the trade a handsome blotter, printed in two colors, announcing their removal from 117 Lake street to large and commodious quarters at 358 Dearborn street. Both companies are experiencing a large demand for mica and micanite materials, and the trade west of Ohio and Pennsylvania is handled by the Chicago house, where a large stock is carried, enabling the company to make prompt shipments.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., is distributing price-list No. 10, covering D & W enclosed fuses and safety devices. In this price-list every line of new code fuses is listed, and the arrangement and classification have been given careful consideration, with a view to making the book a compact and convenient reference. The Central Electric Company, as the general western selling agent for D & W fuses and safety devices, will mail one of these catalogues to any user of electrical material on request.

THE DALE MANUFACTURING COMPANY is sending out from its building at Ninth avenue and Thirteenth street, New York city, a very attractive series of cards, eyeleted for convenient suspension, illustrating and pricing Dale's "Leaders" in six divisions. These comprise gas, electric and combination fixtures, and while the prices given are extremely low, the company announces that the workmanship and finish are of the highest order. Illustrations of the full line, with discounts, will be mailed upon application. These fixtures are made in two, three and four lights.

THE AMERICAN ELECTRIC AND CONTROLLER COMPANY, New York, heretofore located at No. 12 Dey street, has taken offices in the Electrical Exchange Building, 136 Liberty street, New York, where it has on exhibition a line of its specialties. It has ready for distribution a list of bulletins as follows: No. 1, describing the "Rheocrat;" No. 2, applications of the "Rheocrat;" No. 3, electrically operated switches; No. 4, automatic starters for induction motors; Nos. 5 and 6, applications of automatic starters; No. 7, solenoids for direct and alternating-current service; No. 8, applications of solenoids. On request it will furnish free of charge a suitable binder in which these bulletins can be preserved.

THE LOWE ELECTRIC COMPANY has been incorporated under the laws of the state of New York. Mr. Ernest A. Lowe has withdrawn from the firm of Lowe & Leveridge, and is now treasurer and president of the new company. This corporation will enter the electrical field well equipped to transact various lines of electrical business. In addition to a new and complete stock of electrical supplies, which will be carried at the store, 35 Dey street, New York city, the corporation takes over the manufacturing plant of Robert L. Hailey, 79 Cortlandt street. Mr. Hailey becomes secretary and a stockholder of the new company. The factory will be thoroughly renovated and fitted up with new machinery for quick repairs to dynamos, motors and all kinds of electrical apparatus. The company will also have an efficient construction department for prompt attention to breakdown demands and emergency service.